AIDS TO OPHTHALMOLOGY

N. BISHOP HARMAN

SIXTH EDITION

BAILLIÈRE TINDALL & COX

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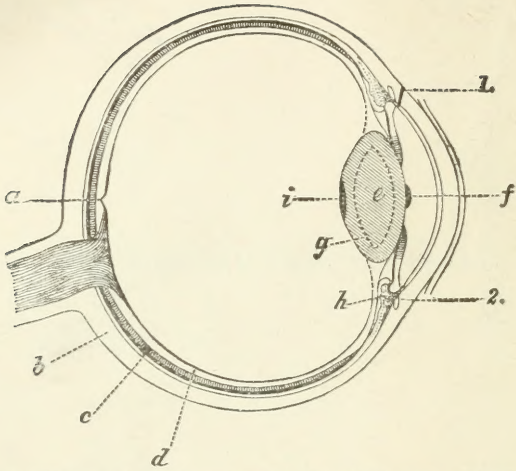

FIG. 1.—Diagram of a horizontal section through the eye. *a*, The fovea centralis or yellow spot; *b*, sclera; *c*, choroid; *d*, retina; *e*, the lens, in which the dotted line *g* marks the position of a lamellar cataract; *f*, anterior polar cataract; *i*, posterior polar cataract; *h*, ciliary body. The line 1 indicates roughly the position of the section made through the cornea in iridectomy and extraction of cataract; 2 points to the canal of Schlemm, which receives the aqueous from the anterior chamber through the spaces of Fontana at the angle betwixt iris and cornea.

AIDS

TO

OPHTHALMOLOGY

BY

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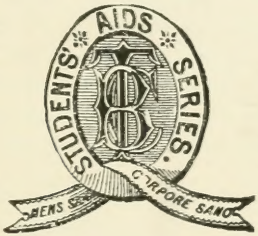
WITH 163 ILLUSTRATIONS

SIXTH 

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PREFACE TO THE SIXTH EDITION

The issue of the fifth edition in 1911 brought valued suggestions from friends, known and unknown. In the preparation of this sixth edition the fullest possible advantage has been taken of these hints, with the result, it is hoped, that weak points have been strengthened and good points bettered.

The whole book has been carefully revised. Several new illustrations have been added. More space has been given to Glaucoma, Squint, and Malingering. By request the chapters on Muscle Balance and on Ocular Therapeutics have been extended, and one on the Diseases of the Vitreous introduced.

The seven chapters on Refraction form a concise but complete guide to the student, for the lines followed are those that have been proved sound in teaching at the West London Post-Graduate College. Few students find time to investigate this branch of ophthalmology before graduation, but that step passed, the necessity for mastering the art becomes increasingly apparent.

As in previous issues, rare diseases are intentionally omitted, but it is hoped no point essential to the knowledge of the ordinary ophthalmic diseases and injuries has escaped notice.

N. BISHOP HARMAN.

108, Harley Street, W.,
May, 1919.


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I. INTRODUCTION.

In no part of medicine or surgery is there such scope for nicety of observation as there is in eye-work. The parts under examination are delicate in the extreme, and the science and art of ophthalmology has developed to a degree that gives the surgeon all the advantages of objective examination, and leaves him but little dependent on the subjective impressions of the patient.

To secure these advantages in his own experience, the worker must follow the royal road beaten smooth by his predecessors, and that road has but one rule—be systematic: examine each part of the eye and its appendages in the order of their ease of approach. If he will take this road he will surely find the object of his search—a reasonable knowledge of his patient's disorder, and one that will help him to a good diagnosis and efficient treatment, with a subsequent result that will be a gratification to himself and a satisfaction to his patient.

One great advantage the eye-worker has over his brother-surgeon, in that he can see with his own eyes almost every part of the field of his work. No student of Sir George Murray Humphry could forget an aphorism which he never failed to impress upon the members of his clinic: 'In surgery, eyes first and most, fingers next and little, tongue last and least.' And if the aphorism be true for general surgery, it is much more true for eye-work. It is scarcely necessary to expand so neat a saying.

II. THE EXAMINATION OF THE EYE.

In examining an eye, note first its *setting:* the physique of the patient, his general health, his face, his expression and complexion. Then, beginning with the eyelids, go through the whole of the appendages of the eye to the eye itself. And when 'eye' is written, the term is used collectively; it includes both of a patient's eyes. The examination of the two should run concurrently, for the state of an apparently healthy eye will often give the clue to the origin of a disorder in the other eye, which by itself might be indeterminate.

The examination of the eye will naturally follow in this order:

Eyelids.
Orbit.
Lachrymal apparatus.
Conjunctiva.
Sclera.
External muscles.
Cornea.
Anterior chamber.
Iris.
Pupil.
Lens.
Vitreous.
Objective examination of refraction.
Ophthalmoscopical examination of optic disc, retina, and choroid.
Subjective examination of vision: (1) acuity; (2) field; (3) colour-sense.

Oblique Illumination.—In examining the superficies of the eye the worker should stand with his back half turned to a good light—daylight preferably and place the patient to face him squarely, so that the light falls well on his face. The minute details of the superficies are best seen when strongly illuminated, and this can be obtained by focussing the light

with a good lens: one of 13 dioptres, having a diameter of a couple of inches, and fitted with a handle, is most convenient. If the lens be held at its focal distance from the eye, the part upon which the light falls will be brilliantly illuminated, and stand out in marked contrast to the surrounding area in the shadow. To obtain the best effect the lens should be held so that its axis coincides with the path of the light rays.

The Corneal Loupe.—For minute examinations, especially of the cornea, the iris, and the front of the lens, a loupe, a powerful lens, magnifying about 10 diameters, is necessary.

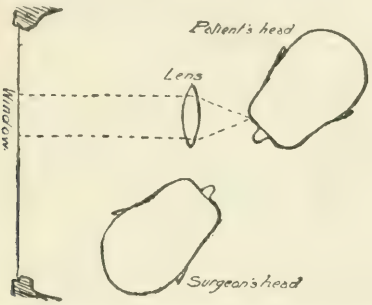


FIG. 2.—Plan of positions in examination with oblique illumination.

The eye is illuminated in the same way as above, but the worker holds the loupe closely to his own eye, and through it makes a minute examination of the part illuminated.

A somewhat similar result can be obtained by using the ophthalmoscope for direct examination, and viewing the superficies of the eye through the +20 D lens of the instrument; but the cornea will be seen against the background of the illuminated retina, so that marks on the cornea will show up as dark spots on a red ground. This mode of examination is most useful for examining the crystalline lens, and by varying the lens in the sight-hole of the instrument the successive media of the eye can be examined from the cornea to the retina.

Binocular Magnifiers.—For those who have perfect binocular vision, the binocular loupe is of great value. It gives magnification not only of the superficies as does a single lens, but also of the depth of the object viewed; consequently the curved surface of the eye, the anterior chamber and the iris, are viewed under exceptional advantage. The instrument is of great value in the removal of foreign bodies from the cornea, and in needling operations after cataract extraction.

A simple formula (for emmetropes) in spectacle form is:

R. and L. eyes: +5 D spherical c̄ 9° Prism Base In. Round lenses set in frame with narrow bridge, and long side bows, angled 15° at hinges. The bridge should rest on the tip of the nose to carry lenses as far from the eyes as possible.

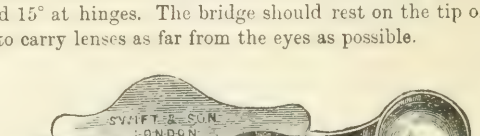


FIG. 3.—Corneal loupe.

Eversion of the Eyelids.—One of the most important manœuvres the worker must master is that of bringing the conjunctival surfaces of the lids into view. The lower lid is easily pulled down, and when the patient looks up the conjunctiva covering the lid and the fornix is exposed. The upper lid, however, is not so easily dealt with, and by reason of the extent of the conjunctiva covering it and the deep upper fornix, its greater liability to disease and to harbouring foreign bodies, it is the more important region to examine. Yet to the practised hand everting the upper lid is a simple and nice performance; it is scarcely more difficult than depressing the lower, and it can be done with as little discomfort to the patient.

All that is needed is the worker's thumb and index-finger and *the patient's lower lid.* So far as the manœuvre can be

put into words, it is described here: Stand facing the patient; use right hand for left eye, and left hand for right eye. Tell the patient to look down; place the inner edge of the thumb parallel with the lower lid and on its outer half, just below the lashes. Place the inner edge of the index-finger lightly on the upper lid, just above the lashes, and gently push up the skin; this will cause the edge of the lid to lift from the globe just a little. Now, with the thumb in position, slip the lower lid under the upper lid, and the thumb, following the lower lid, will get under the upper lid, which can be held firmly betwixt thumb and first finger and everted, even against a vigorous orbicular spasm. Bear in mind that the secret of the trick is to make the lower lid do the work of raising the upper, and you cannot fail to get the knack of it with a little practice.

The Upper Fornix.—When the upper lid is everted, the deep reflection of the upper fornix is still unexplored. It is important to examine it, for large foreign bodies may be tucked away in its depth. We may examine the fornix by lifting the projecting edge of the tarsus and looking beneath it. Or the fold may be made to pout outwards by gently pressing upon the globe through both the everted upper and the lower lids. The second method should only be attempted in young healthy eyes (under twenty-five years of age); in older subjects and where the arteries are diseased the pressure on the globe is not unattended with danger.

Palpation.—The eye and its adnexa are palpated to ascertain—(1) abnormal shape, (2) tenderness, (3) the tension of the eye. Palpation is always performed through the lids.

1. The bony margins of the orbit are examined for irregularities; the lachrymal sac is pressed upon to see if fluid regurgitates from the puncta; inequalities of contour of the globe, or protrusions beneath the conjunctiva, are felt through the lids.

2. Gentle pressure is made over the ciliary region in suspected cyclitis; the globe is pressed backwards in suspected optic neuritis, to discover if there be pain on pressure.

3. Tension.—*The tension of the eyeball.* The eye is palpated to ascertain its resilience, just as the surgeon examines for 'fluctuation' in an abscess or cyst. The student should never miss an opportunity of examining the tension of normal eyes. To know the feel of a healthy elastic eyeball is the best preparation to recognize variations from health. A nervous patient may jump when two fingers are placed on his eye, and the movement may cause a jar from fingers held stiffly, and a jar in old people may lead to serious intra-ocular hæmorrhage; hence there is a rule, to which there is no exception; fix your hands on the patient's head, so that they move with every movement of the patient. To examine an eye, make a 'bridge' (as in billiard play) of each hand, place thumbs down on the maxilla, and spread all fingers fanwise on temple and forehead. Now tell the patient to look down; bring down the index-fingers side by side below the eyebrow; push them as far back under the brow as possible; and, holding the globe steady with one finger, gently press the globe with the other finger. By the sensation of elasticity and the impulse conveyed through the globe from one finger to the other we judge the tension of the eye. We record it as 'normal,' 'plus' for hard eyes, and 'minus' for soft eyes, and grade it in degrees of 1, 2, or 3. Thus, in an eye with absolute glaucoma, T = + 3; in an eye with detached retina, T = – 3.

Sensibility.—The sensibility to touch of the conjunctiva and cornea is determined by stroking these surfaces with a wisp of cotton-wool. The conjunctiva varies greatly in sensibility in its parts, but the healthy cornea is exquisitely sensitive.

The Pupils are large in children and their reactions wide and brisk; they are smaller in adults, sometimes only of pin-point size, and their reactions are smaller. Frequently the pupils are slightly excentrically placed, usually slightly to the nasal side.

Normal Pupil Reactions.—These are three; they should be tested in every subject:

1. The direct light reflex. Light thrown into the eye causes the pupil to contract. Test the eyes simultaneously by

covering them and uncovering them quickly; also test each separately whilst the other is kept covered. The reaction in each eye should be equal. If the reactions are difficult to detect examine in the dark room by suddenly exposing the eye to a bright light. A binocular magnifier is useful in such cases.

2. Consensual reaction. Light thrown into one eye causes the pupil of the other eye to contract also. The reason for this lies in the connection of the optic ganglia with the motor nuclei of both sides by the posterior longitudinal bundle. The reaction is best seen thus:—Hold the hands an inch or so before each of the patient's eyes, look under one hand and watch the pupil; now quickly remove the hand from before the other eye. The pupil of the shaded eye should contract.

3. Accommodation reaction. The sphincter of the iris contracts with the contraction of the ciliary muscle, for both have the same nerve supply. Let the patient look into the distance, note the size of the pupils; then let him look quickly at a finger held six inches from his nose; note contraction of pupils.

For the paths of the light reflexes see Fig. 73.

Pupil reactions can be produced by reflexes (*a*) sensory, *e.g.* dilation on pin-pricks, (*b*) cerebral, dilation in angry passion.

Hippus.—The normal pupil is always in motion, minute fluctuations in size can be detected with the corneal loupe. In abnormal states of the nervous system, and occasionally of the circulation, the movement is slow and wide so that it can be seen by the naked eye; this is called 'hippus.'

Ophthalmoscopy.—The student should never miss an opportunity for practising the use of the ophthalmoscope. Whatever work he may ultimately take up, the capability of seeing with his own eyes under a high magnification a field of nerve tissue, a nerve head, and a spread of arteries, veins and capillaries, must always be to his advantage.

Direct Method.—The examination is made eye to eye as closely as possible. Light is thrown into the patient's eye by means of a small concave mirror tilted at an angle. The rays reflected from the fundus are brought parallel by the patient's lens and

cornea (if not, the lenses in the ophthalmoscope are used), and these are seen by the surgeon. The fundus is seen right way up and magnified about 15 diameters.

Indirect Method.—The surgeon sits at arm's length and throws the light into the patient's eye by means of a concave mirror about 1½ inches diameter. The rays coming from the eye are received by a convex lens (about 13 D) held 4 or 5 inches from the eye, this lens focusses the rays to form an inverted image in mid-air, which the surgeon sees. Less magnification but a wider view is obtained by the indirect than by the direct method. The student usually finds the indirect method the easier to begin with. A couple of hints may be given :

1. Apply the rule of golf : 'Let your stance be easy.' Sit comfortably, with your eyes on a level with your patient's eyes ; let body and head be held easily, and the grip on the instrument be as light as possible. If the student be not comfortable, he will see nothing.

2. Never tire of examining normal eyes, such as those under a midriatic for refraction purposes. A good atlas of fundus drawings should be examined—either that of Haab, Lindsay Johnson, or the beautiful work of Adams Frost.

Retinoscopy.—See chapters on Refraction.

Visual Acuity—1. *Distant Vision.*—This should be tested first in all cases. The usual test is Snellen's types. At 6 metres the smallest object that can be seen in a good light by an

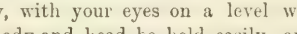


Fig. 4.—The basis of Snellen's types. At 6 metres each square and space subtends an angle of 1′ ; the eye should see them as distinct dots at this distance.

average eye subtends a visual angle of 1′ ; if the space between two black squares on a white card be smaller than is subtended by this angle, the separation of the squares cannot be seen. The line of squares shown in Fig. 4 are drawn to this scale. The student with normal distance vision should see that the line is made up of separate dots when the test is held 6 metres from him in a good light.

The letters in Snellen's types are built upon this plan. The letters to be seen at 6 metres subtend a 5′ angle in height, and are 1′ angle in thickness of line. Above these letters are other sizes, which should be seen at 9, 12, 18, 24, 36, and 60 metres. If the patient reads the smallest, we note his visual acuity thus: $V = \frac{6}{6}$—*i.e.*, at 6 metres he reads the 6-metre letters. If

Fig. 5.—A letter of Snellen's types (D = 6) to show how it is built up.

he can only read the 18-metre letters at 6 metres, we note, $V = \frac{6}{18}$, and so on.

If $\frac{6}{6}$ cannot be seen, the patient may be brought nearer. If the top letter cannot be read at any distance, we try his ability to count fingers at any distance; failing that, his perception of hand movement: or failing that, his perception of light (PL), by alternately covering the eye and throwing a bright light upon it.

Fig. 6.—Scheme showing gradation of Snellen's types.

2. *Near Vision.*—Jaeger's types are used. These are different sizes of printers' types—the smallest No. 1 = diamond, the largest No. 20 = 8-line roman.

Field of Vision. — Vision includes not only the distinct appreciation of the object fixed by the macula, but also the less distinct appreciation of the surrounding objects whose images fall upon other parts of the retina. The area over which these objects are seen is bounded by the prominences of brow, nose, and cheek; but outwards it is only limited by the shape of the

eye itself. We can measure this field of vision. A perimeter is necessary for accurate measurement. This instrument is a graduated quadrant, pivoted so that it can be brought to all parts of the field in turn. One eye is closed. The eye to be examined looks at the pivot, then a square card, white or coloured, is passed along the quadrant until it comes into view ; the place is marked on a chart ; so the perimetry of the field is recorded in all positions.

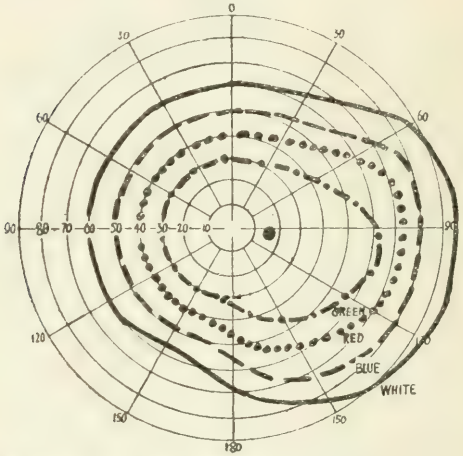


FIG. 7.—Normal field of vision, right eye, for white and colours. The black spot to the right of the centre is the 'blind spot,' the site of the optic disc.

It is well to take the fields in some habitual manner. A good plan is to map out the periphery with a 20-millimetre object ; then to map out the normal blind spot with a 2-millimetre object. Lastly, by turning the arc of the perimeter in circles, search the field for any areas of indistinct vision, or scotomata—*i.e.*, abnormal blind spots.

Without a perimeter the field may be roughly estimated

thus: Let the patient stand with his back to the light, cover one eye, and fix the surgeon's nose with his other one; then a square of paper, mounted on a long penholder, is moved away from the fixation-point in all directions, the patient giving the word when it goes out of sight. In this examination the surgeon faces the patient at a distance of about 18 inches, and the patient looks steadily at the fixation-point.

Mapping the Blind Spot (Bjerum's test).—This is a most important test for chronic glaucoma, and it is quite easily made without special instruments. Take a sheet of black cloth 2 metres square, hang it on a wall, mark the centre with a spot of white paper; now mount a piece of white paper 6 millimetres square on the end of a long penholder. Let the patient stand facing the cloth at the distance of 6 metres, with one eye closed, and fixing the centre spot with the open eye. Now move the mounted test-object about the field, find the blind spot, and map its boundaries. Stick pins into the cloth, as the margins are determined. The test can be performed quite well with a small screen at the distance of 1 metre with test objects of 2-millimetre size.

The character of the field of vision frequently affords most important evidence in the diagnosis of ocular and cerebral diseases of grave character (see index, Field of Vision).

III. BACTERIOLOGY.

For the examination of discharges from the eye the student should be able to make film preparations and inoculate culture tubes.

1. *Film Preparation.*—Take two clean microscope slides and a sterile platinum loop (in its absence a clean glass rod will do); lift some of the discharge from the depth of the lower fornix, and make a circular smear on each glass slide. If the discharge is watery, try to secure a pledget of mucus; if it be thick, first wipe the excess of discharge from the conjunctiva with sterile wool.

2. *Inoculation of Culture Tube.*—Slants of inspissated blood-serum are the most useful. Invert the culture tube and

remove the plug; slip in the platinum loop carrying the discharge; make two light strokes on the serum—first one side, then on the other; flame the plug, and replace in the tube. Many organisms grow best or only when supplied with fresh blood; this is best obtained from the conjunctiva of the lid to be examined. If the conjunctiva be very inflamed, rubbing with the loop will draw blood; if not, prick a small vessel with a sterile needle, mix the blood with the discharge, and inoculate culture tube.

3. *Collection of Discharges.*—If no serum tubes are available, take a piece of narrow glass tubing, heat, and draw out into a pipette; suck up the discharge into the pipette, and seal the ends in a flame. The fluid can be safely kept for as long as a day before using for inoculation of tubes.

FIG. 8.—Pipette for collecting discharges.

4. *Staining.*—Two methods are in general use—(1) Staining with an aniline dye: Loeffler's alkaline methylene blue is excellent. Pour some stain on the smear, leave for ten minutes, wash lightly in water, then dry and mount. (2) Gram's method is an invaluable micro-chemical test for certain organisms. Stain with fresh aniline gentian violet solution for half a minute; drain off excess; place in Gram's solution (weak iodine and pot. iod. in water) for one minute; now wash in absolute alcohol until no stain comes away; wash in water; then counter-stain with Bismarck brown, wash, dry, and mount. The gonococcus, the colon, the Koch-Weeks and the Morax-Axenfeld bacilli, are decolourized by Gram's method. Others—*e.g.*, staphylococci, streptococci, pneumococci, xerosis, and Klebs-Loeffler bacilli—stain a deep purple. A microscope fitted with a one-twelfth oil immersion objective and Abbé condenser is necessary to see these organisms.

Contents of the Anterior Chamber.—In irido-cyclitis it may be necessary to obtain cultures from the turbid aqueous as a first

step in securing vaccine treatment. The chamber may be punctured, and its contents drawn off by a small syringe armed with the author's aqueous needle. Touch the conjunctiva at a

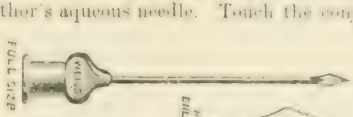


FIG. 9.—Harman's aqueous needle for tapping the anterior chamber.

spot close to the cornea with a cautery to sterilize it, then insert the needle obliquely under the corneal margin and withdraw a few drops of aqueous into the shaft of the needle.

IV. THE CONJUNCTIVA.

The lids are dermal folds, specially modified to the service of the eye. On their outer surfaces they present a covering of delicate and loosely attached skin; on their inner side they present a most delicate mucous membrane, the conjunctiva, which is reflected from the lids on to the exposed front of the eyeball.

From its origin the conjunctiva should possess all the equipment of true skin, but by development these accessories have been beautifully adapted to their special service. Thus hairs are relegated to the edges of the lids, where they act as a *chevaux-de frise*: the sebaceous glands are ranged in a row and open on the lid margins, to lubricate them in their rapid contacts; the sweat glands are enlarged, and massed as the tear glands. The whole surface retains its primitive mucus secreting capability; each cell produces mucin, and in time disgorges its contents on to the surface of the membrane, lubricating its movements. Everywhere the membrane is transparent, so that the underlying vessels and Meibomian glands and the colour of the sclera can be clearly seen.

The conjunctiva varies in thickness. Over the lids it is thick and attached to the underlying tissue, particularly over

the upper tarsal cartilage, where it is thrown into permanent folds; the crypts between these are known as 'Henle's glands.' The epithelium is of transitional type; the stroma is of an adenoid character, and contains minute collections of lymph cells, which in diseased states may be grossly enlarged.

The conjunctiva is simplest at the folds where it passes from lids to globe (the fornices), and where it covers the front of the globe. There it is a thin, elastic, connective tissue membrane, covered by laminated pavement epithelium; it is so elastic and so loosely attached to the underlying tissues that in inflammation it may be swollen to a great size (chemosis). At the limbus of the cornea, it is firmly bound down, and its epithelium covers the cornea, forming its outer layer. Within the inner canthus are the plica semilunaris and caruncle; they represent the shrunken remains of the third eyelid of lower animals. Hairs frequently grow from the caruncle.

The lymphatics of the conjunctiva are numerous; they radiate from the cornea, and pass by the outer canthus to the pre-auricular gland. When a stye attacks the outer canthus, there is often much œdema, because the lymph paths are blocked.

Bacteriology of the Normal Conjunctiva.—Since the conjunctiva is continually exposed to the air, numerous micro-organisms obtain access to it. Some are so commonly found thereon as to be considered habitants. Thus, of 100 school-children examined by the author, in only 23 could no organisms be found on the conjunctiva. In the others diphtheroid bacilli were found in 36, and staphylococci in 53. Pathogenic organisms were much less frequently found: thus the *Bacillus Koch-Weeks*, the cause of epidemic muco-purulent catarrh, was found in 1; the *Bacillus Morax-Axenfeld*, the cause of angular conjunctivitis, in 3; the pneumococcus in 1; and streptococci in 4.

The great liability of the conjunctiva to infection can be shown by the fact that 27 different organisms were found in these 100 children, and more were found in dirty children than amongst clean children.

The same applies to the condition of the lid margins; there

can always be obtained from them numerous organisms, most frequently the *Staphylococcus albus* or *Staphylococcus epidermidis albus*.

V. CONJUNCTIVITIS.

Classification may be made either by reason of the clinical features of the inflammation, or by the cause that produces it. The latter is the rational mode; but since our knowledge is not complete, our classification is imperfect. Clinically there are two groups of cases:

1. Those that run an acute course, are catarrhal, and when successfully treated leave no permanent damage. The group includes simple catarrhs and catarrhs of greater severity, even to purulent inflammations.

2. Those which run a chronic course, exhibit hyperplasia in a marked degree, and tend to leave permanent traces of their action. In this group trachoma is the chief exemplar.

Catarrhal Group.— In no disease can the classical features of inflammation be better seen: redness, heat, swelling, and pain. Redness from distension of the vessels, and sometimes from minute hæmorrhages. Heat from the hyperæmia; the temperature of the normal conjunctiva ranges from 3° to 4° F. below body temperature, but in hyperæmia it rises to nearly body temperature. Swelling varies from a barely perceptible œdema to a swelling so intense as to render lids and globe immobile, and the skin may be swollen and glassy looking. Pain is always present in acute cases: it is peculiar that patients complain of the sensation of sand or grit in the eye, even sometimes of 'a feeling as if broken pieces of glass were rolling under the lids.' We may suppose this is due to the training of the nerves to warn us of the presence of foreign bodies, so that we receive their impression of the inflammatory disturbance in terms we are accustomed to.

The inflammatory reaction affects all the neighbouring glands. Tears are excessive; the Meibomian glands are stimulated, and their secretion becomes frothy; the mucous secretion of individual cells of the mucosa is greatly increased; small

pledgets of mucus may be seen in the tears, and in microscopic sections of the inflamed mucosa numerous goblet cells are seen.

In more severe cases pus cells mingle with the discharge in large numbers; it becomes muco-purulent, or in the worst cases purulent. In intense inflammations the initial discharges may be serous or sanguineous; these readily dry on the edges of the lids, sealing them down.

Excluding cases where the eyes are closed by œdema of the lids, there is even in slight cases some blurring of vision. By the suffusion of tears, the deposit of floating particles upon the cornea, and the greater or less degree of swelling of the corneal epithelium (for this is part of the conjunctiva), the cornea loses in clearness.

Simple Conjunctivitis.—Mild attacks of catarrh may follow any irritation—exposure to wind, dust, smoke, fumes, heat, or accidental splashes of foreign fluids—and the attacks may pass as readily as they came. The reflex irritation of septic teeth, nasal douches, gastritis, or the ingestion of stimulating foods, will produce the same symptoms. On occasion exposure to bright light will produce conjunctivitis, or even œdema, and there may be involvement of the nasal mucosa with sneezing and coryza. Similarly, prolonged use of the eyes where there is an error of refraction will produce transient attacks of conjunctivitis.

The excretion of drugs by the mucosa, such as arsenic, or of products of metabolism in gouty subjects, produces similar irritation of the conjunctiva.

When these causes of irritation are repeated or prolonged, a chronic form of conjunctivitis results; the 'eyes are always bloodshot, sore, and watery.'

The number of conditions capable of causing conjunctivitis shows how important it is in any case of conjunctivitis to seek out the cause of the irritation, and to remove that, and not to trust to relief by the use of lotions and ointments

In England all forms of conjunctivitis are more common during March, April and May, than in other seasons of the year, for then the dry, gusty winds scatter the dirt of the

streets broadcast. Also, conjunctivitis is more common amongst dirty, ill-kept folk than amongst those of cleanly habits.

There are certain forms of conjunctivitis caused by specific micro-organisms.

Angular Conjunctivitis.—A mild but chronic condition, causing redness of the lids, particularly at their angles, whence the name 'angular.' The ocular conjunctiva is but little affected. The secretion may contain minute bubbles, so that it appears like frothed white of egg; this is caused by the excessive blinking of the lids. When the lids are screwed up, the secretion is squeezed out at the angles, and the skin surface becomes sodden. The disease is slightly more common amongst

FIG. 10.—Film preparation of discharge, showing Morax-Axenfeld bacilli. *l*, Leucocyte; *e*, epithelial squame. (× 750.)

women than men, and it is less often found amongst children than adults. The disease is rarely complicated by corneal trouble.

The *organism* causing the disease is a thick, square-ended diplobacillus (Morax-Axenfeld), staining well with aniline dyes, but decolourized by Gram's treatment. It is easily demonstrated in film preparations. It grows on dried serum slants, liquefying the serum in deep, sharp-edged pools of turbid fluid. The fluid contains numerous bacilli, in short lengths or long chains, and showing swollen involution forms.

Muco-Purulent Conjunctivitis.—This form of catarrh is very contagious. It frequently occurs in epidemics If it appears

in a household, all the members are likely to be attacked. The subjective symptoms differ only in degree from those already described. Objectively, it is characterized by the constant presence of pale greyish-yellow pledgets of muco-pus in the lower fornix and lacus lacrimalis, by a marked hyperæmia of the whole conjunctiva, by a tendency to a velvety condition of the upper and tarsal conjunctiva, and by minute hæmorrhages about the loosely supported vessels of the ocular conjunctiva.

The lymph follicles of the lids are swollen, and appear as slightly raised pinkish-grey bodies about 0·5 to 1 millimetre in diameter. Commonly the attack begins in one eye, and then

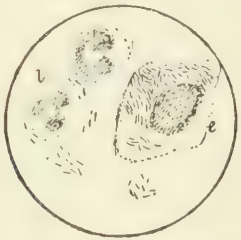


FIG. 11.—Film preparation of discharge, showing Koch-Weeks bacilli. *l*, Leucocyte; *e*, endothelial squame crowded with bacilli. (× 750.)

affects the other. Sometimes the pre-auricular lymphatic gland is inflamed.

The Organism.—When the muco-purulent discharge of such a case is examined microscopically in a film preparation and stained with Loeffler's methylene blue, a delicate rod-shaped organism can be found — the Koch-Weeks bacillus. It was discovered by Koch in Egyptian ophthalmia, and studied by Weeks of New York. It has been found in large numbers of epidemics of muco-purulent catarrh in all parts of the world. The organism is small, measuring about 1·5 μ in length, and $\frac{1}{10}$ to $\frac{1}{12}$ its length in breadth. It is frequently slightly nipped in or unstained at its middle. It stains with aniline dyes, and not by Gram's method. It can be grown upon serum slants

when the discharge is mixed with blood. The colonies are exactly like dewdrops. In most of its features the organism is like the bacillus of influenza—in fact, some workers have sought to prove that the organisms are one and the same.

Complications of Muco-Purulent Catarrh.—Sometimes the symptoms are so severe and the discharge so profuse that the case may be mistaken for a purulent inflammation. In severe cases sharp-edged crescentic ulcers, 'catarrhal ulcers,' occur on the margin of the cornea; they are most frequent when there is œdema or a hæmorrhage at the limbus. The swelling interferes with the nutrition of the corneal epithelium. The ulcers are more frequent in old than in young patients. In the East these ulcers are a fruitful source of damaged eyes; in England they are rarely dangerous.

In children a circumcorneal crop of phlyctenules is by no means uncommon (see p. 33).

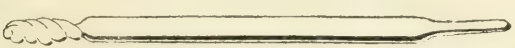


FIG. 12.—Glass rod, taper-ended, with cotton-wool swab twisted thereon. Pigments are best applied to the conjunctiva with such a swab. (× ⅔.)

The Treatment of the foregoing forms of conjunctivitis, where there is a definite sepsis, is clearly to get rid of the invading organism.

The surgeon should initiate this by carefully washing out the conjunctival sac with boracic lotion, and then painting the everted lids, fornices, and particularly the folds of the inner canthus, with a solution of silver nitrate; a solution of 0·5 per cent., 1 per cent., or at most 2 per cent., in distilled water is sufficiently strong. The solution works best, and is less painful of application, when it contains 20 per cent. of glycerine.

The silver solution should only be used by the surgeon; he should not order it as 'drops' for the patient's own use. Patients have a habit of continuing treatment indefinitely. Silver salts, if long continued, are absorbed and deposited in the elastic fibres of the submucosa, and ultimately the whole conjunctiva and cornea may become stained blue-black (argyrosis).

For the patient's own use an eye-wash (collyrium) or drops (guttæ) should be ordered. The wash is best, provided the patient gets it into the eye, and does not merely bathe the skin of the lids. He should be taught to lie on his back, to run the lotion into the lower fornix with a glass dropper, and then to roll the lids over the globe with his finger. The operation should be repeated until the due portion of the lotion has been used. If this ablution is efficiently performed it matters little what drug is in the lotion, if only it be weak enough not to cause severe smarting. A solution of boric acid, 2 per cent., is harmless and extensively used. A solution of zinc sulphate, 0·5 per cent., is very commonly employed ; it is particularly useful in angular conjunctivitis. Zinc chloride, 0·1 per cent., is useful to interchange with the sulphate, particularly in muco-purulent catarrh. Copper sulphate or alum solutions, 0·1 per cent., are sometimes useful astringents when muco-purulent symptoms are prolonged. Under no circumstances should lead lotions be used for the eyes. Lead is readily absorbed by an abraded cornea, and remains permanently as a white mark, which may obscure vision.

Purulent Ophthalmia.—A severe and dangerous form of conjunctivitis, due in nearly all cases to contagion from gonorrhœal discharges. It is most commonly seen in infants, infected by vaginal discharges at birth (*ophthalmia neonatorum*). The discharge is noticed about the third day after birth ; the lids become red and swollen, and their edges stick together ; on opening them yellowish pus and lymph exude, and on everting the lids the conjunctiva is seen to be extremely congested and velvety. There is great risk to the cornea from ulceration or sloughing if the disease be neglected, with consequent incurable blindness. In the London County Council Blind Schools 25 per cent. of the children are blinded by this one cause. From inquiries made in London by the author it was concluded that of every 100 children born one suffered from the disease, and of every 2,000 born one was blinded or partly blinded by the disease.

The disease is preventable. Gibson of Manchester in 1807

recommended that—(1) The leucorrhœa of the mother ought, if possible, to be cured during pregnancy. (2) When this has not been done, the noxious secretion ought to be removed from the vagina during delivery. (3) The infant's eyes ought, immediately after birth, to be cleansed with a fluid which either removes the noxious matter or is able to prevent its injurious effects. Mackenzie in 1830 wrote: 'The eyes of the infant should be carefully washed as soon as it is removed from the mother.' Veteh (1807) observed that if accidental splashes of

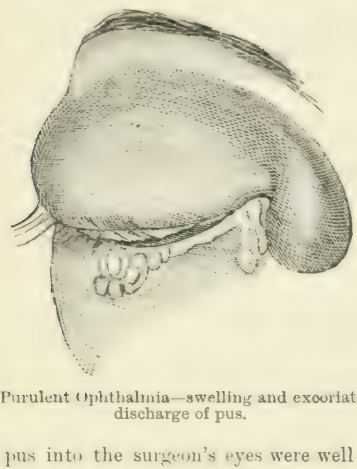


FIG. 13.—Purulent Ophthalmia—swelling and excoriation of lids, discharge of pus.

gonorrhœal pus into the surgeon's eyes were well washed out, no inflammation followed. Piringer (1841) showed that no ill effects followed the experimental inoculation of gonorrhœal pus on to the human conjunctiva, provided it was well washed out with water within three minutes of inoculation.

In 1880 Credé advised the instillation of 2 per cent. silver nitrate solution into the conjunctival sac as soon after birth as possible, as a mode of killing the gonococcus should it have gained access to the conjunctiva. The method has been singularly successful in lying-in institutions. At Leipzig,

where Credé worked, before 1880 the incidence of ophthalmia neonatorum was 10·8 per cent.; after the adoption of the silver drops it fell to 0·1 per cent. Occasionally a smart inflammatory reaction, 'silver catarrh,' follows the use of the drops, but it is rarely dangerous. It has now been ascertained that a 1 per cent. silver solution is quite strong enough. Some workers prefer 1 in 5,000 perchloride of mercury; but silver is more effective, since it has a selective action on the intercellular cement substance where the organism spreads.

Preventive Measures.—1. Directly the head of the infant is born, wipe the eyelids dry with clean cotton-wool. Use a fresh piece for each eye; burn it after use.

2. As soon as the mother is settled, wash the eyelids of the infant freely with a simple lotion (boracic or Condy, 2 per cent.), and run plenty of clean fluid between them. The water used in the first bath of the child must not get into the child's eyes; separate water and towel must be used for the face. At no time during the lying-in period may the mother's sponges, napkins, etc., be used for the child.

3. If, at delivery, there be a suspicion of a purulent discharge from the vagina of the mother, cleanse the eyes as directed above, and wash thoroughly; then instil a drop of silver nitrate, 1 per cent., between the lids. The eyes must be re-examined and washed at the end of eight hours, and if there be any suspicion of discharge the silver drop may be repeated. In case of doubt, make and examine film preparations of any discharge without delay.

Notification. — Conjunctivitis in the new-born is now scheduled as a notifiable disease by many British health authorities (Infectious Disease [Notification] Act, 1889).

Bacteriology.—In all cases of purulent discharge in infants, two film preparations of the pus should be made—one stained with methylene blue, the other by Gram's method (p. 12). If groups of biscuit-shaped cocci be found within the leucocytes, and stained by the blue and not by the Gram, the presence of the *Micrococcus gonorrhœæ* of Neisser is sufficiently established for clinical purposes.

Eighty per cent. of these cases are gonorrhœal, and these are the only cases dangerous to sight. The remaining 20 per cent. are cases of milder order, and due to accidental inoculation with the Koch-Weeks bacillus, colon bacillus, or the pneumococcus.

Treatment.—These cases require constant attention; they should be taken into hospital, or special nurses put in charge day and night. The surgeon should never omit to examine and note down the state of the cornea as soon as he sees the case.

Treatment consists in (1) cleansing; (2) use of a germicide. (1) The cleansing is the most important part. The eyes should be cleansed free of pus every hour, and irrigated at least six

FIG. 14.—Film preparation of discharge, showing the gonococcus. Note the numbers within the leucocytes. *l*, Leucocytes; *e*, endothelial squame. (× 750.)

times in the twenty-four hours with plenty of boric acid lotion. No instruments that deliver the fluid under pressure may be used (such as squirts or large irrigators), and no instrument (save a retractor, Fig. 22) is to be thrust between the eyelids. The 'Undine' is the safest irrigator (Fig. 15); the snout must be quite short, and guarded by a piece of rubber tubing. After the douche the skin of the lids should be dried with cotton-wool and greased with vaseline, to prevent gluing of the lids and excoriation. (2) Germicide: Once a day after the conjunctiva has been cleansed, the surgeon should evert the lids, and carefully swab the whole conjunctiva, avoiding the cornea, with a solution of silver nitrate of 1 per cent. strength in water

with glycerine (p. 19). If the cornea becomes hazy or an ulcer appears, continue the silver and douching, and instil atropine drops, 1 per cent., after each douche. Should the ulcer deepen and threaten to perforate, attempts may be made to check its course by cauterizing its surface, either with carbolic acid or the actual cautery (see pp. 55 and 56 on Atropine and Cautery).

If only one eye of the child be affected, let the child be lain on the side of the affected eye, so that discharges drain away from and not towards the sound eye. Carefully cleanse the sound eye twice a day, wash your hands before touching it, and use separate vessels, lotions, and wool for that eye.

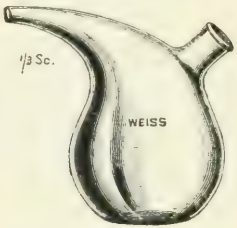


FIG. 15.—Douche bottle, or 'Undine,' for irrigating conjunctiva.

In gonorrhœal conjunctivitis of adults the contagion is generally conveyed by the finger from the urethra. Commonly one eye only is affected ; the sound eye must be protected with a Buller's shield. The ocular symptoms are intense in proportion to the recentness of the urethral infection. The symptoms are similar to those described in infants, but of greater severity. There is more chemosis of the ocular conjunctiva, so that the swelling may be stiff and hard, and there is much greater risk to the cornea, for the chemosis cuts off the corneal nutrition. The discharge for the first day or two is serous or sanguineous, and becomes purulent less early than in infants. The pain is great. The lids are red and hot, and often so greatly swollen as to prevent examination of the eye. During the initial stage of

irritation strong antiseptic solutions should not be used; they increase the irritation. Repeated irrigation with lukewarm lotion, boracic, 2 per cent., or quinine, 1 per cent., cold cone presses, and leeches to the outer canthus, all help to reduce the intensity of the congestion. It may be necessary to split the outer canthus, to relieve the pressure on the cornea and to allow of its inspection. As soon as the chemosis softens, the conjunctiva should be swabbed with 1 per cent. silver nitrate once or twice daily, followed by washes of saline solution or boracic, to neutralize the silver and wash off the precipitate.

FIG. 16.—Buller's shield for protecting sound eye in purulent conjunctivitis. (× ½.) It is secured in position with flexile collodion; a gap with a cotton-wool wick is left at the outer side for ventilation.

In severe cases of chemosis the cornea early disintegrates, and it is impossible to save it. When ulceration appears later, interference may be attempted with advantage—either by the use of carbolic or the galvano-cautery, or, when perforation threatens, by section of the cornea.

The later stages of purulent conjunctivitis are often lingering; the conjunctiva is relaxed and very velvety—'sarcomatous,' as our forefathers named it. It is well to stop the silver for a few days at intervals, and use zinc sulphate (1 in 100 or 1 in 200) solution. To reduce a persistently relaxed conjunctiva the use of solid copper sulphate may be required.

In a few cases gonococcus vaccine has been used with benefit, particularly in the later stages.

Sequelæ of Purulent Conjunctivitis—*Keratomalacia.*—In marasmic children, particularly where silver nitrate is used for too long a time, the cornea may become dry and white (see Xerosis, p. 37).

Leucoma Adherens.—When the cornea is perforated, the iris is washed into the opening by the escaping aqueous ; there follows an anterior synechia fixed to a white scar.

Fig. 17.—Anterior staphyloma with synechia.

Anterior Staphyloma. — When an eye is lost by a large perforation, iris and cornea become matted in granulation tissue, which ultimately produces a dense scar. The natural flow of the fluid of the eye from posterior to anterior chamber is checked ; the scar bulges, producing hideous staphylomata, and in later life the eye may burst or require removal. This chain of events can be forestalled by a judicious iridectomy as soon as the perforated eye has become quite quiet. The section should be made where the healthiest remnant of cornea

and iris remains. A successful iridectomy leaves a clear opening, through which some vision will be possible.

Anterior Polar Cataract.—When the cornea perforates, the aqueous escapes, and the cornea falls back into contact with the lens. The nutrition of the anterior capsule of the lens suffers, so that granulations spring up within it, which later consolidate into a fibrous plaque, forming an anterior polar cataract (see Fig. 1, *f*).

Nystagmus (see p. 158) is a frequent sequela of ophthalmia neonatorum, even when the damage to the cornea has been small.

Conjunctival Scarring.—After severe conjunctivitis (not necessarily purulent) the granulations leave a permanent scarring of white lines in the mucosa, like corded silk.

Membranous Conjunctivitis.—An inflammation of the conjunctiva of such severity that the layers of the mucosa are killed to a greater or less depth. Any quickly acting irritant is capable of producing this. Painting the conjunctiva with a solution of silver nitrate of 2 per cent. will kill the surface epithelium, which can be peeled off as a grey pellicle. The same changes may be seen in cases of conjunctivitis of no great severity.

When micro-organisms of great virulence act upon the conjunctiva, the inflammation is so intense that the mucosa, and even the submucosa, is killed; the dead tissue remains *in situ*, embedded in fibrinous exudation, and forms a false membrane. When this is stripped off, the bared surface is raw, and bleeds. In these cases the lids are much discoloured, hot and tender, and so hard and swollen as to be parted with difficulty; membranous patches may be seen on the skin.

There is much chemosis of the ocular conjunctiva. The discharge is profuse and serous or blood-stained; it readily dries on the lashes, sealing the lids; later it becomes purulent.

The danger to the cornea is great; ulceration and perforation, with eventual blindness, are to be feared. The patient, usually a child, is prostrated; albumin may be found in the urine; the temperature is raised. The disease runs a rapid course. Fatal cases have been recorded.

The *organisms* responsible for these graver cases are the virulent diphtheria bacillus (Klebs-Loeffler) and the *Streptococcus brevis*. The latter has been found responsible for some severe cases in children. If the diphtheria bacillus be present, the constitutional symptoms are marked.

Treatment.—The patient must be isolated. Bacteriological diagnosis is urgent. If diphtheria be proved, antitoxin treatment is invaluable. If the case be due to streptococcal infection, a vaccine may be used, but its success is not great. Locally, in

Fig. 18. — Drawings of various forms of diphtheria and diphtheroid bacilli. (× 750.) *a*, Short form, slightly curved, nip-waisted; *b*, short segmented form; *c*, long form; *d*, long form, with segmentation and clubbing—some clubs are rounded, others pointed; *e*, very long form, with marked segmentation, almost simulating cocci; *f*, double-clubbed form.

Diphtheria bacilli of all sorts tend to fall into groups like Chinese characters. In discharges forms *a* and *c* are most usual; in cultures segmentation and clubbing increase with age—*e.g.*, *d*, *e*, .

the early stage, cold compresses and free douching with warm antiseptic lotions are required. Tweedy recommends 1 per cent. quinine lotion. Strong or irritant solutions of drugs must not be used: they increase the chemosis and necrosis; but it is well to use 1 per cent. solution of silver nitrate with glycerine once a day, provided it is thoroughly washed out with saline solution and cool compresses are applied immediately after. In the later stages frequent cleansing of the eye to remove sloughs and discharge, and the use of an astringent lotion, are indicated; cicatrization of the raw surfaces tends to

produce deformities of the lids—trichiasis, entropion, and symblepharon (see p. 106, on Lime Burns).

Follicular Conjunctivitis.—Scattered over many parts of the conjunctiva, immediately beneath the epithelium, are numerous minute collections of lymph cells—solitary follicles. These are plentiful in the lower lid, numerous in the retrotarsal folds, sparse over the upper tarsal plate, absent over the ocular conjunctiva. Brush, their discoverer, likened them to the follicles of Peyer's patches. In 1,000 healthy London school-children they were visible in 58 per cent. : infants, 42 per cent. ; boys, 52 per cent. ; girls, 73 per cent.

In debilitated, pasty-faced, flabby children the follicles are more evident than normal, and their enlargement may be associated with adenoids and enlarged tonsils. Such children are more liable than well-kept children to conjunctivitis, due to any invading organism. Epidemics of conjunctivitis in schools frequently present these features.

Treatment.—Improve the health and environment. Use astringents locally if there be any discharge.

Trachoma.—This is often spoken of as 'granular lids,' since the inflammation involves chiefly the palpebral conjunctiva. It is a very chronic disease, lasting one or more years, causing much hypertrophy and scarring of the conjunctiva and injury to the cornea, with reduction or loss of sight. It is seen chiefly amongst the poor, dirty, and overcrowded. It is exceedingly common in Egypt (hence 'Egyptian ophthalmia'), where MacCallan found it in 51 per cent. of school-children ; common in Eastern Europe ; but not common in England. Only five cases were found amongst 70,000 London school-children.

Symptoms.—Often the presence of the disease is unsuspected until the lids are everted. Usually there is more or less photophobia and discharge, with lachrymation. There is slight ptosis, and the edges of the lid are purplish and thick. When the lids are everted, the upper lid is found most affected. The papillæ are exaggerated, so that they look like plush pile (papillary form), and the lymph follicles of the eye are enlarged

and prominent (granular form), so as to suggest sago grains or frog's spawn. Both features may present in one case (mixed form).

The discharge is intermittent and contagious; it is rarely great in quantity.

Pannus.—As a result of the irritation of the cornea by the rough lids, there is a growth of new vessels and soft connective tissue between Bowman's membrane and the epithelium. It usually affects the upper part of the cornea in a wedge-shaped patch, apex downwards; ulcers frequently form at the apex. The pannus obscures the sight (Fig. 36, B).

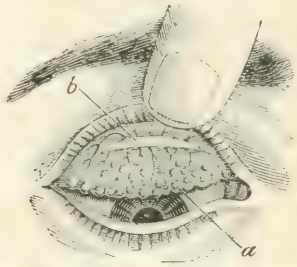


FIG. 19.—Trachoma, upper lid everted: *a*, enlarged follicles; *b*, scar tissue

Pathology.—Sections of the conjunctiva show, in addition to enlarged papillæ, leucocytosis, and massive follicles, a marked exaggeration of the endothelial stroma, with formation of giant endothelial cells (multinucleated). This stroma tends to envelop the follicles in a capsule, and cure only results when the stroma has shrunken into scar tissue.

Ætiology.—We are ignorant of any one and certain cause. The contagiousness would suggest a specific microbe. Koch and other workers found in Egyptian cases the gonococcus, Koch-Weeks bacillus, Morax-Axenfeld bacillus, pneumococci, and other cocci. In cases seen in England all these have been found—except the gonococcus. Many attempts have been made to establish some particular organism as the prime cause,

but without complete success. Recently Halberstadter and v. Prowazek have published accounts of certain cell inclusions —'trachoma bodies'—which, treated by the Giemsa method, appear red in a blue field; these have been recognized by other workers in fresh untreated trachoma, but similar bodies have been found in other conditions, and it is held that they are granules from broken-down leucocytes. It is quite possible that the disease is a chain of pathological events produced by the irritation of one or more of several organisms in subjects who are habitually ill-conditioned.

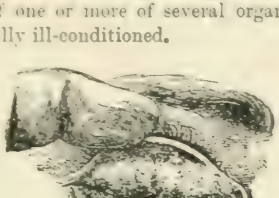


FIG. 20.—Trachoma, lids everted. There is gross hypertrophy of the lymph follicles and papillæ, producing a cauliflower-like exuberance.

Treatment.—No treatment is known which will produce a rapid cure, and attempts to effect this by too vigorous cauterization or scraping away the granulations usually lead to excessive scarring and entropion. On the other hand, much good may be done by improving the patient's general health, and methodically using astringents to the everted lids for a period of many months.

1. In the discharging stages paint daily with 1 or 2 per cent. of silver nitrate.

2. In the chronic velvety stage apply an approved caustic (bluestone or carbon dioxide snow) to the everted lids once or twice a week.

3. If the condition is very inert, much good results by *gently* scraping the papillæ with a sharp Volkmann's spoon (Fig. 24).

4. In follicular enlargement unload the conjunctiva of the

follicles by *gently* squeezing the everted lids with Graddy's expression forceps.

Before the operations of scraping or expression, solid cocaine may be rubbed on the mucous membrane, and after the operation the surfaces should be well washed with water.

Caustics: 1. Bluestone is a time-honoured application, and as valuable as it is ancient. Its drawback is the intense pain produced, which is not lessened by cocaine. Evert the lids, and lightly rub with crayon or crystal twice a week.

2. Carbon dioxide snow is now extensively used, with gratifying results. A thoroughly hardened candle of the snow is shaped to the lid to be treated, and pressed firmly

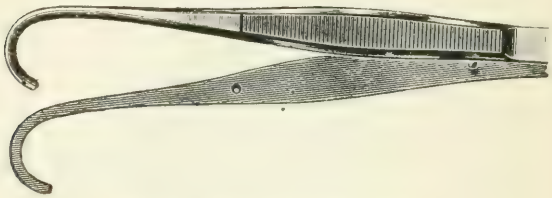


Fig. 21.—Graddy's expression forceps.

upon the part for fifteen to twenty-five seconds; the tissue is whitened with the cold (*B.M.J.*, October, 1910, p. 1311).

Begin with brief applications, and increase their duration as the patient becomes used to them. Once weekly is sufficiently frequent. The application is practically painless; there is some throbbing when the part thaws.

Both bluestone and snow are used to cause a reaction; this sets up a leucocytosis, and eventually a fine scarring, which destroys the trachomatous process.

The use of caustics (bluestone or snow) should be stopped at intervals of two months for a week, then irritation subsides, and the effect produced can be seen. The patient should be given an astringent lotion wherewith to clean the eyes thrice daily during the whole course of the treatment.

Electrical treatment (cautery, X-rays, high-frequency current, electrolysis) have all been used without permanent benefit.

Complications.—Pannus is best relieved by treating the lids; if iritis threatens, use atropine. In old-standing pannus the operation of peritomy is beneficial: dissect off the strip of conjunctiva from around the cornea, so as to cut off the vessels running into the cornea. Years ago it was noticed that dense pannus sometimes cleared up after an attack of gonorrhœal conjunctivitis, and to this end inoculation of pus was practised. Infusion of jequirity, or jequiritol (a new extract), produces a similar and less objectionable inflammation, the intensity of which may be modified, if necessary, by an antiabrinic serum. The results are not always satisfactory.

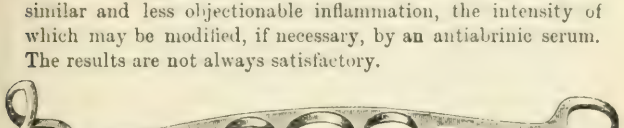


FIG. 22.—Author's eyelid retractor. It is made of steel, so cannot get out of shape. The fenestrated handle gives an easy grip, even when the fingers are wet.

If the scarring of the lids is severe, trichiasis and entropion result. Treatment of these deformities is urgent, as they irritate the cornea and increase the pannus (Operations, see p. 175).

Phlyctenular Conjunctivitis (and Keratitis).—There is no disease which is responsible for more damaged eyesight than this. The cornea is frequently affected, and even if the ulcer be small, there is left a scar or dimple which seriously reduces visual acuity (Fig 39).

Symptoms.—Photophobia and blepharospasm, small efflorescences of the limbus and subsequent ulceration. Photophobia is so marked a symptom that, should a child of four or five years be brought for examination with the eyelids tightly screwed up and red with tears, the diagnosis of phlyctenule is almost sure. It is essential to examine the cornea. Place the child on a couch and roll it in a blanket; gently part the lids—tears usually squirt out—insinuate a retractor beneath the upper lid and draw it up. The cornea will be found

turned up and out; a little patience, and it will be turned down. One or more small whitish elevations will be seen about the limbus, heading a leash of enlarged surface vessels, which point towards the centre of the cornea. Photophobia and lachrymation are the first symptoms, so a case seen early may show no phlyctenule. In later stages the elevation will be found to have collapsed, leaving an ulcer, which tends to spread towards the centre of the cornea, with its leash of vessels.

Seat of Election.—Of ten years' cases seen at the Belgrave Hospital, it was found that 70 per cent. of phlyctenules occurred about the temporo-malar quadrant of the limbus of the cornea, on that part supplied by the orbital branch of the second division of the fifth nerve; of these, 29 per cent. spread on to the cornea. One-half of all these cases were cured in a week. When the cornea was affected, cure was delayed. In about 3 per cent. of all cases there developed a severe, relapsing, and chronic keratitis (p. 52), running for months, even years.

Pathology.—It is a disease of the **poor** and of **young children.** Cases are rare in the first year of life, and most common from four to six years of age, when the milk teeth are decaying. The children very commonly suffer from chronic coryza, have sores about the nostrils and lips, eczema of the face, perhaps discharging ears. The children are **ill-fed.** The disease is much less frequent amongst Jewish children than natives. Jews feed their children well, and use much oil in cooking. We may note here cod-liver oil is the best cure for the disease.

The earliest observers considered phlyctenules were minute blisters (hence the name). Later, sections were made, showing solid elevations of leucocytes between the epithelium and basement membrane about the ending of a nerve. Some of my sections show fibrin between the leucocytes, and von Michel has found cavities in some cases. The 'seat of election' and the histological feature suggest that the lesion is a herpetiform eruption, caused by peripheral irritation of collateral branches of the second division of the fifth cranial nerve in ill-nourished children.

Bacteriology.—Many workers have sought to discover a specific

organism. None are in agreement. In early cases examined by myself (*a*) the conjunctiva was found to be freer from microbes than normally owing to the wash of the tears; (*b*) the contents of unbroken phlyctenules were sterile.

Attempts have been made to show that the lesions have a definite association with tubercle, 'caused by tubercle toxins circulating in the blood.' Crops of phlyctenules have occurred after injections of tuberculin, but examination of the opsonic indices of cases tends to negative tubercle. Such crops are not uncommon in acute muco-purulent catarrhs from invasion of the Koch-Weeks bacillus; they occasionally follow the use of atropine ointment in debilitated children. There is no evidence to show that phlyctenules are tuberculous, but of course they are as likely to occur in tubercular children as in other weakly, ill-fed children.

Blepharospasm.—In severe irritation of the fifth nerve there is a reflex through the seventh nerve, causing contraction of the orbicularis palpebrarum. If the symptom be so severe that the eye cannot be opened, an anæsthetic should be used to examine the eye.

Lachrymation.—A small branch of the lachrymal branch of the first division of the fifth nerve unites with the orbital branch of the second division in the supply of the 'seat of election'; hence these tears.

Treatment.—1. Good food and cleanliness are of the first importance. Cod-liver oil, plenty of fat food—milk, cream, and butter.

2. Clean the teeth; relieve stomatitis. Clean up all sores on face; they heal rapidly after painting with 5 per cent. silver nitrate.

3. For the eyes, when there is much photophobia, insert 1 per cent. atropine ointment (in vaseline and lanoline equal parts) between the eyelids thrice daily. The base forms a warm, soothing covering to the conjunctiva; the atropine quiets the ciliary muscle and iris. Provide a large pent-roof shade to shelter both eyes.

In later stages insufflation of calomel by the surgeon is valu-

able (must not be given if iodide is administered). In most cases there is used an ointment of reprecipitated yellow oxide of mercury (1 per cent.), with or without the atropine, as the degree of irritation suggests. Later, the oxide may be increased to 2 per cent.

A single fresh phlyctenule may sometimes be aborted by touching it with a 1 per cent. solution of silver nitrate. In cases of crops of phlyctenules in muco-purulent catarrh, treat the catarrh and instil atropine.

Tuberculosis of the Conjunctiva.—A rare condition most frequently associated with lupus of the skin of the face. It is characterized by large soft granulations in the fornices, studded with miliary tubercles. Usually there is some infiltration of the sclero-corneal margin and of the cornea, so that vision is reduced.

Treatment is best effected by thorough removal of the granulations by scraping and subsequent insufflation with iodoform.

Parinaud's Conjunctivitis.—A monocular affection showing swelling and infiltration of the lid and large 'vegetations' of the conjunctiva—at first translucent, later opaque and yellow. Discharge is mucous and fibrinous.

The pre-auricular gland and those of the jaw and neck are inflamed and may suppurate. The condition may last six months. Parinaud thought it due to transference of some infective agent from animals to man. Whether or no the condition is a distinct entity is debatable.

Spring Catarrh.—Uncommon in England. Each spring the patient suffers an attack of acute conjunctivitis, which lasts through the hot, dry weather. The conjunctiva is seen to be thickened: that of the lower lid looks milky; that of the upper lid, owing to the enlargement and flattening of the papillæ, looks like a mosaic. Occasionally small nodular thickenings with small vesicles appear at the limbus. The fluid in the vesicles contains numerous eosinophile cells. Section of the conjunctiva shows exaggeration of the fibrous elements of the subepithelial tissue, particularly in a small spindle-cell formation; the epithelium is thicker. The condition is probably a keloid scarring of the conjunctiva.

Treatment.—There is only trouble during hot, dusty weather; therefore institute a régime of regular douching with saline solution and massage when spring approaches. Beware of mistaking it for trachoma and aggravating it by use of strong drugs.

Xerosis Conjunctivæ—1. *Epithelial Xerosis.*—A slight drying of the conjunctiva. There are white, frothy patches on the inner and outer quadrants of the ocular conjunctiva close to the margin of the cornea. This froth is Meibomian secretion mingled with xerosis bacilli (one of the diphtheroid group). Found in unhealthy, poorly-fed children, and associated with night-blindness; also found in adults suffering grave cerebral disease. A graver form of epithelial xerosis, associated with keratomalacia and marasmus, occurs in infants as a sequela to ophthalmia neonatorum.

For all these cases good food and cod-liver oil internally and castor-oil drops to the eye bring relief.

2. *Parenchymatous Xerosis*, or essential shrinkage and atrophy of the conjunctiva, is a grave change following severe inflammation and injuries—*e.g.*, trachoma and lime burns. The conjunctiva loses its delicacy and transparency; the epithelium becomes dry and horny; the stroma shrinks, destroying the tear glands; the cornea becomes dry and white, and sight is lost. Treatment is of no avail.

Pinguecula.—The yellow body so commonly seen on the inner quadrant of the ocular conjunctiva, close to the limbus. It is due to thickening of the subepithelial tissue, and to a deposit therein of fatty colloid substances. This part of the conjunctiva is that most exposed to wind and dust.

Pterygium.—This is a development from the pinguecula; it is a triangular fold of conjunctiva, usually at the inner quadrant, sometimes at the outer also. Its apex gradually encroaches on the cornea and may obscure vision.

Treatment.—Lift the fold with forceps, pierce it through with a tenotomy hook, and strip it off the cornea; snip off the excess of conjunctiva, and close the opening with a stitch.

False Pterygium.—When the corneal margin suffers a severe injury—*e.g.*, a burn—the conjunctiva may become firmly at-

tached to the site, forming a bridge of tissue. If it causes trouble carefully release it from the cornea with sharp scissors, and stitch back into place.

VI. DISEASES OF THE LIDS.

Blepharitis is an inflammation of the margins of the lids, and involves the follicles of the lashes, their glands, the Meibomian glands, and the strips of skin and conjunctiva bordering the margin. It is one of the commonest of eye diseases amongst children. Of 351 cases of external eye disease seen amongst 22,000 School Board children in London, 270, or nearly two-thirds, were varieties of blepharitis; and it was twice as often seen amongst dirty children as amongst clean children.

The inflammation may be either acute or chronic in its course. When acute it is usually started by an inflammation of the skin of the lids or of the conjunctiva; thus it is particularly frequent after measles and scarlet fever, which affect both these structures, or after eczema of the skin. In mild chronic cases blepharitis is usually a sign of irritation caused by an error of refraction.

Symptoms.—The lids look sore. A slight gummy discharge, minute ulcers with a deposit of crust along the edges of the lids, and dropping out of the hairs, are the chief symptoms. In inveterate cases the hair-bulbs are destroyed, and a condition known as lippitudo produced; there may then be epiphora, due to eversion of the lids. The longer the disease has existed the more difficult it is to cure. Ulcers of the cornea and phlyctenular conjunctivitis are not infrequent complications.

Treatment.—Order the patient to remove all the scabs by bathing with warm alkaline lotion (20 grains of carbonate of soda to the ounce) two or three times a day, and afterwards to apply a dilute mercurial ointment (the Unguentum Hydrargyri Nitratis Dil., or one containing 2 to 4 grains of the yellow oxide to the ounce of vaseline and lanoline). Painting the edges of the lids with a 5 per cent. solution of nitrate of silver often does good, and in cases where the hair-bulbs are obviously

inflamed epilation may be required at intervals. Attend to the patient's general health, and if there be any error of refraction correct it with appropriate glasses.

In chronic blepharitis with recurrent styes the use of staphylococcic vaccine, prepared from the patient's own organism, or a stock preparation of mixed organisms, has frequently proved very satisfactory.

Chalazion (syn., Meibomian Tumour or Cyst).—Small rounded tumours in the substance of the eyelid, which commence in

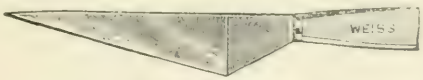


Fig. 23.—Beer's knife.

the Meibomian gland layer. They were formerly wrongly supposed to be glandular cysts due to duct-obstruction, but are really made up of a gelatinous mass of small cells, the effects of microbic irritation. They tend to inflame and suppurate. They occur most often in young adults, and are noticed as firm rounded lumps under the skin of the eyelid. Some patients show a marked tendency to their repeated development. They are most common in the upper lid.

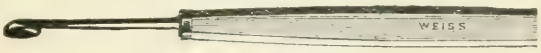


Fig. 24.—Sharp spoon.

Treatment.—Evert the eyelid, make an incision with a Beer's knife into the tumour from the conjunctival aspect vertical to the lid margin, introduce a small sharp spoon, and scrape out thoroughly the granulation mass. It is convenient to hold the lid in Graddy's forceps (Fig. 21) to prevent bleeding during the operation. Pass the finger over the eyelid to ascertain that the tumour is completely removed.

A **Stye** is a pustule or small abscess at the margin of the lid, probably around one of the sebaceous or other glands at this part. It has nothing to do with the Meibomian glands.

Treatment.—Pull out the lash at the inflamed point if the case is seen early, then apply hot boracic fomentations; and incise when there is a definite abscess. Attend to the patient's general health, as styes tend to recur.

Horns grow generally from the middle of one or other eyelid; they are usually met with in elderly people, and seem always to commence in connection with a sebaceous gland. Hence, though towards the apex they may be very hard, at their base they are comparatively soft.

Treatment.—Excise with scissors or knife, taking care to remove the base of the horn to prevent recurrence.

Molluscum Contagiosum occurs in young children, and is characterized by little round or oval projections, which generally show a dimple at their summit. They occur in crops on the face (the eyelids are a favourite site) or other parts of the body; they may become pedunculated, and may then inflame and drop off. They are contagious in a mild degree; for example, they are sometimes seen on an infant's face and on its mother's breasts or hands, and can be inoculated with difficulty. Microscopically they consist of lobulated masses of peculiar cells, resembling sebaceous matter, but they do not appear to originate in sebaceous glands.

Treatment.—If pedunculated, snip them off with scissors; if not, cut into the little tumours and squeeze out their contents, then touch each bleeding-point with a match soaked in pure carbolic.

Xanthelasma Palpebrarum depends upon the presence in the skin of the eyelids of cells containing a peculiar yellow fat, in and just beneath the rete mucosum. The favourite site is the inner part of the upper eyelid, and the affection is generally symmetrical. A yellowish patch (not unlike wash-leather in appearance) is seen, slightly raised, and supple to the touch. Develops usually after middle life, especially in those who are prone to deep pigmentation of the lids (patients who suffer from frequent bilious headaches, etc.). Cauterizing the patches with trichlor-acetic acid is sometimes effective.

Syphilitic Ulcers. — Both primary chancres and tertiary syphilitic sores are occasionally met with. Chancres are always accompanied by characteristic gland enlargement in the pre-auricular or submaxillary region. Tertiary ulcers are difficult to cure, and tend to relapse ; the patients are most often women who have had syphilis severely. Iodoform applied locally, with iodide of potassium given internally, or salvarsan, together with tonics, constitute the chief methods of treatment.

Rodent Ulcer is a peculiar form of epithelioma, characterized by the following features : (1) Very slow growth ; but in some cases, if left alone, it tends to eat steadily into the tissues below, destroying the lids and globe, and even invading the bones. (2) The ulcer has a raised, sinuous, 'rolled' edge. (3) The lymphatic glands are not involved, however long the disease has lasted. (4) Microscopically there are down-growths of epithelium derived from the rete mucosum, or deeper layer, and not containing cell-nests like ordinary epithelioma. The cells in the down-growing bands are smaller and less defined than those of epithelioma. Although it may start at any part of the eyelids or adjoining skin, the commonest place is the lower lid, towards the inner canthus.

Treatment.—1. Excision. There is no doubt that the most effective treatment is excision. When the ulcer is small the operation is trifling and the scar negligible. Where extensive removal of tissue is necessary—*e.g.*, the excision of one eyelid—a skin flap should be arranged so as to take its place, or a V—Y incision made (p. 178).

2. X-rays, radium, and electrolysis of zinc ions have each proved effectual in some cases ; radium is particularly good, although it has been known to fail.

3. Carbon dioxide snow is probably the best treatment short of the knife. Prepare a hard candle, cut the end to the shape of the ulcer, and apply with firm pressure for forty seconds. There is no pain, but some throbbing on thawing out. The area heals with a soft supple scar, which does not contract. Watch the case for some months subsequently, lest any part should have escaped destruction.

Dermoid Cysts.—The favourite position for congenital cysts about the orbit is over the external angular process of the frontal bone, to the periosteum of which they are nearly always attached, and often they somewhat indent the bone. As they lie under the frontalis muscle the skin over them is movable. Their fibrous wall is very variable in thickness, and their contents consist of cholesterin, sebaceous matter, abortive hairs, and more or less fluid. They often reach the size of a hazelnut in the first year, and show little tendency to increase subsequently.

Treatment.—Thoroughly cleanse the skin. Thrust a sharp-pointed knife through the swelling from side to side and lay open; evacuate contents of cyst; seize the tough wall with forceps, twist it into a cord, detach it from its connection with a blunt dissector, and remove; stitch up the wound, and seal with gauze and flexile collodion.

Trichiasis.—Inversion of the lashes, a frequent result of the scarring of the lids by trachoma; the lashes scrape the cornea, causing pannus (operation, p. 177). A loose lash may slip butt-end foremost into a punctum and cause irritation of the conjunctiva, simulating phlyctenule. The occurrence has been noted in both eyes at one time.

Distichiasis.—'Double row of eyelashes.' A rare congenital condition, occasionally hereditary. The invagination of the epiblast for the growth of Meibomian glands is misdeveloped; some or many of these glands are replaced by hairs. When they impinge on the cornea they should be removed by electrolysis.

Lice (*Pediculi pubis*) are occasionally seen on the lashes of very dirty people. In neglected cases there may be rows of nits on the lashes.

Treatment.—Slide off the nits from the lashes, or else remove the lashes; smear with yellow ointment.

Entropion.—Inversion of one or both lids. It is nearly always due to scarring of the conjunctiva and underlying tissues, particularly of the tarsal plates, which may be permanently curved and deformed. Its most frequent cause is trachoma, and hence it is specially met with in the upper lid.

The eyelashes become turned inwards towards the globe, so as to keep up constant irritation of the cornea, and this often leads to, or is associated with, pannus; operation is needed for its relief (p. 177).

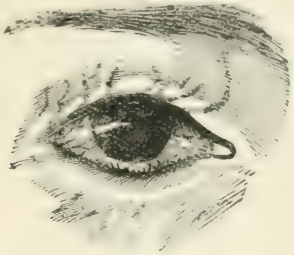


FIG. 25.—Entropion of both lids.

Spasmodic entropion of the lower lid occurs fairly frequently in old people in whom the eyelids are loose and lengthy. It would appear that the orbicularis contracts irregularly and curls over the lid edge. If the condition tends to become chronic relieve by operation (p. 178). A similar condition is

FIG. 26.—Ectropion of both lids, with conjunctivitis.

sometimes met with after operations on the eye—*e.g.*, cataract extraction—then it is due to presence of the bandages, which had better be discarded, or replaced by a raised shield.

Ectropion.—Persistent eversion of the lid (nearly always the lower one), which usually produces displacement of the lachrymal

punctum, and more or less epiphora. Mild degrees are seen in old people with chronic conjunctivitis; more severe forms are due to scarring from various causes—burns, tubercular periostitis of the upper jaw, wounds with loss of substance, operations for removal of rodent ulcer, etc. Ectropion, if persistent, may be relieved by operation (p. 178).

VII. LACHRYMAL DISEASES.

It will be remembered that the tears, after leaving the ducts of the lachrymal gland beneath the outer end of the upper lid, are swept across the eye by the action of the orbicularis pal-

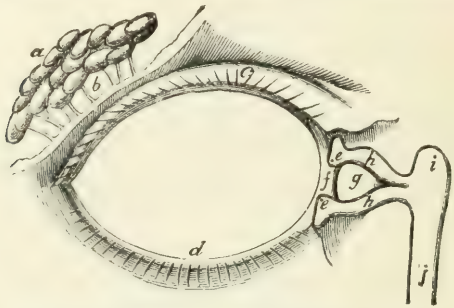


FIG. 27. — Lachrymal apparatus. *a*, Lachrymal gland; *b*, ducts; *c*, *d*, margins of lids; *e*, *e*, puncta lacrimalia; *g*, caruncle; *h*, *h*, canaliculi; *i*, lachrymal sac; *j*, nasal duct.

pebrarum, which has its chief fixed point at the inner canthus. At the same time, partly by the action of the tensor tarsi, the two puncta at the inner border of each lid are opened and directed to receive them. They then pass along each canaliculus into the lachrymal sac, and down the nasal duct to the inferior meatus of the nose. Any interference with the muscular mechanism, with the position of the puncta, or any obstruction to the drainage apparatus, will cause the tears to flow over the cheek—a condition known as *Epiphora*. Hence

epiphora is met with from a variety of causes—facial paralysis (involving the orbicularis and tensor tarsi), chronic blepharitis or ectropion (displacing or obstructing the puncta). Perhaps the most common cause is chronic inflammation of the nasal duct, leading to stricture. The latter may be due to disease of the nasal bones (as in inherited syphilis); it has been known to follow periostitis of the face set up by dental disease, and it has been caused by fracture of the nose from falls, blows, etc.; but sometimes no certain cause can be found. It may develop at any age, and is most common amongst females (80 per cent. —Nettleship). The tears collect in and distend the lachrymal

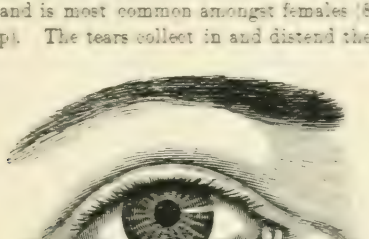


FIG. 28.—Lachrymal abscess, which has burst below the tendo oculi.

sac, forming a **mucocele**; pressure over the site of the sac will cause regurgitation of its contents through the puncta on to the conjunctiva.

At first the condition is only an annoyance from the overflow of tears or mucus and the resultant eczema of the skin below the lids. When the contents of the sac become infected with organisms then it presents a serious risk not only of lachrymal abscess, but also to the eye; a slight abrasion of the cornea may be infected from a septic sac and a hypopyon ulcer set up with disastrous consequences to the sight.

Treatment.—Where the epiphora is due to blepharitis or chronic conjunctivitis (particularly gouty), and where there is

no mucocele, and hence probably no obstruction to the escape of tears, astringent lotion or drops should be tried : sulphate of zinc ¼ to ½ per cent., chloride of zinc 1 in 1,000, or the conjunctiva may be painted with a weak nitrate of silver lotion ½ per cent. (not in gouty cases). In cases due to displacement of the puncta relief may necessitate operation for ectropion

Fig. 29.—Weber's canaliculus knife.

(p. 178). Some surgeons prefer slitting up the lower canaliculus with a probe-pointed knife (Fig. 29). In this operation the surgeon stands behind the patient, insinuates the probe point within the punctum, makes the lower lid tense, and straightens the canaliculus by drawing the lid outwards with one index-finger, while he pushes on the blade of the knife, at the same

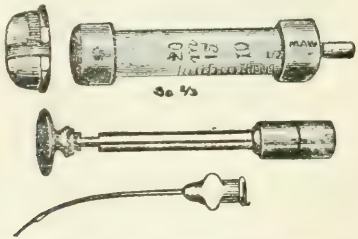


Fig. 30.—A successful lachrymal syringe. The circular groove on the piston forms an air-cushion, and makes the fit perfect. When not in use the piston should be kept separate from the barrel.

time raising its handle, so as to cut through the whole length of the upper wall of the canaliculus. To prevent the edges of this wound from uniting, cut off the posterior lip with fine scissors.

Mucocele.—If this be present, three lines of treatment are open, and may be tried in sequence.

1. *Daily Syringeing of the Sac.*—The surgeon dilates the lower punctum, inserts the fine nozzle of a syringe, and injects boracic lotion (Figs. 30 and 31). In catarrh and swelling of the sac and duct walls, this treatment is most efficient if it be carried out with patience and perseverance. The passage is freed in a few weeks if the nose be healthy.

2. *Probing the Duct.*—Probing as a means of forcing a stricture is now practically extinct, for it was found that the lacerated

Fig. 31.—Nettleship's punctum dilator.

tissues formed a new and tighter stricture; but it is of great value as a means of diagnosis. If syringeing fails, dilate the punctum and canaliculus, pass a Bowman's probe, and feel the obstruction in all directions for a passage. Force must not be used; a false passage makes matters worse. If the probe pass, leave the case until the next day; then syringe the duct, and note if the patient swallows the fluid. If fluid passes, repeat the daily syringeing, and teach the patient to do it himself. Do

Fig. 32.—Lachrymal style.

not syringe immediately after probing; it is a dangerous practice, and has set up cellulitis.

Some surgeons favour the use of leaden styles, solid or hollow; one is inserted, and the upper end rounded off and hooked over the lid to prevent it slipping; it can be worn for months without discomfort, but it must be removed occasionally, cleaned, and the duct syringed.

3. If there be an impassable or bony stricture, the lachrymal *sac should be excised* (p. 180). This is necessary—(*a*) where there are recurrent inflammations of the sac; (*b*) in

workmen liable to injuries to the eye by foreign bodies ; (*c*) when operations on the globe are required. A septic sac will infect a trifling injury or wound of the globe, and the eye may be lost. When the sac is removed excess of tears gradually ceases, and there is no inconvenience except in cold winds.

Lachrymal Abscess.—A suppuration in the lachrymal *sac* If it be on the point of bursting, open it by incision just below the tendon oculi, clean out the sac, then pack sac and wound with gauze. Foment with hot boracic.

Lachrymal Obstruction in Infants.—Occasionally where the puncta are normal there is epiphora of one eye, with or without mucocele, lasting for months. It is due to epithelial débris in the duct. Usually syringeing with plenty of fluid clears the duct.

Lachrymal Gland.—Diseases of the gland are very rare. It may be inflamed, and suppurate, and a fistula be formed. It may atrophy as a result of xerosis of the conjunctiva. Cysts (dacryops) are sometimes found. The most common condition requiring note is the presence of accessory glandular masses in the upper conjunctival fornix, they may be so large as to cause remark ; the condition is congenital, and usually bilateral.

VIII. DISEASES OF THE ORBIT.

The cardinal symptom of disease deep in the orbit is **exophthalmos** or proptosis—bulging forward of the eyeball, sometimes to such an extent that the eyelids cannot cover it. Proptosis also occurs in Graves' disease, thrombosis of the cavernous sinus, and in paralysis of all the muscles of the eye.

Periostitis.—Inflammation and thickening of the periosteum, with or without bone disease, may follow injuries, tubercular infection in children, syphilis, or disease in the antrum or ethmoidal cavities. Pain is slight, but tenderness on pressure may be marked. If pus be formed, it spreads forward to the margin of the orbit, causing much swelling of the lids.

Treatment. — Constitutional in a diathesis ; locally, hot fomentations and evacuation of pus where formed. It is well

to sew the lids together when a sinus forms, otherwise scarring will greatly shorten a lid.

Cellulitis.—Acute inflammation of the cellular tissue of the orbit is exceedingly painful. The globe is pushed forward and fixed; the lids and conjunctiva are greatly swollen. Vision may or may not be affected; if it be, papillitis will be seen. There are general symptoms, high fever, and severe headache.

It usually follows injuries or operations from sepsis; it may be part of a pyæmia, or be the result of the spread of local infections of nose or face, or even from the teeth.

Treatment.—Hot fomentations and free incisions through the skin or conjunctiva deeply into the affected tissue.

Tenonitis.—Inflammation of the capsule of Tenon. The capsule forms a serous investment, within which the globe moves, and it partly invests the ocular muscles. It may be inflamed in the course of chronic rheumatism, just like a joint lining. The symptoms are those of a mild cellulitis, with more or less *immobility* of the eye. Both eyes may be attacked. Vision is not affected.

Treatment.—Fomentations and anti-rheumatic remedies.

Angioma.—The vessels of the orbit, arteries or veins, may be greatly enlarged; there may be an arterio venous aneurism, aneurism of the ophthalmic artery or of the internal carotid. There is proptosis and pulsation of the globe. The diseased vessels must be attacked; it may be necessary to ligature the carotids in the neck.

Neuro-Fibromata.—An analogous condition involving the nerves of the orbit; the growth feels like strings of beads embedded in the tissues. There is proptosis, but no pulsation.

Tumours.—Bony growths of the orbital walls, dermoid cysts (p. 42), meningocele, or other benign tumours occur. Sarcomata and gliomata affect the optic nerve, and in these both proptosis and papillitis may be looked for.

Exploration of the Orbit.—For the purpose of diagnosis it may be necessary to explore the orbit with the finger. Entry may be effected by splitting the outer canthus, securing and dividing the external rectus; or it may be

necessary to remove the outer wall of the orbit (Krönlien's operation).

Anophthalmia.—The eyeball may be congenitally absent; probably there is always some small representative of the globe, but so small as not to be recognizable without minute dissection.

Oxycephaly. — Premature synostosis of the basis cranii causing pointed forehead and shallow orbits. The eyes are proptosed and divergent; frequently there is optic atrophy.

IX. DISEASES OF THE SCLERA.

Cornea and sclera form the fibrous tunic of the eye. Both are composed of fine fibres of connective tissue; the former is transparent, but the latter opaque. The sclera has two sets of fibres—a meridional set running from before backwards, a circular set concentric with the margin of the cornea; the fibres are interlaced as web and woof. Between the bundles there are lymph spaces lined by endothelial cells. The sclera is usually white. Pigment cells are found in the deeper layers, particularly in the anterior ciliary region; in some dark races this part is mottled with pigment. In children the sclera is so thin that the uveal pigment beneath gives it a bluish tint.

We distinguish two forms of scleral inflammation: superficial or *episcleritis*, and deep or *scleritis*.

Episcleritis.—Occurs in one or more patches in the ciliary region. There is exudation, forming a yellowish boss or nodule of the sclera about the size of a lentil. The vessels of the site are deeply injected, and stand out coarse and violet-tinted; they are fixed to the episcleral tissue, and cannot be moved with the conjunctiva. There is tenderness on pressure. The disease is chronic, and relapses are frequent. There is a great tendency to implication of the cornea; small patches of infiltration appear close to the scleral lesion (sclero-keratitis). It occurs most frequently in women following sedentary occupations, less often in adults or elderly people of rheumatic or gouty habit. With or without such a diathesis, the determining cause may be an auto-intoxication from chronic consti-

pation, gastritis, septic teeth. For example, an elderly lady suffered severely from episcleritis, which was checked when a chronic bacilluria was relieved.

Locally hot dry applications (a piece of hot brick wrapped in flannel); atropine if there be ciliary pain; and leeches to the external canthus in exacerbations are comforting. Correct any general disorder present.

Scleritis.—The symptoms are similar, but all of greater severity, and involve larger areas of the ciliary region, perhaps the whole of it. There is more or less anterior choroiditis, iritis, and infiltration of the cornea, so that when the attack is recovered from the vision is seriously diminished.

Ultimately the sclera is so weakened that it bulges before the intra-ocular pressure, producing anterior staphyloma, through which the deep colour of the uvea can be seen.

Tubercle and syphilis are the usual exciting causes. In the East leprosy is not rare. Treatment other than constitutional is of little avail.

Ectasia.—Bulging of the sclera. Two forms are acquired: Anterior staphyloma (see scleritis); and posterior staphyloma, stretching of the posterior pole of the eye in myopia (p. 131).

Posterior scleral protuberance of the lower part of the sclera is a rare congenital defect associated with incomplete closure of the retinal cup; it may be associated with coloboma of the iris or choroid.

New Growths.—Primary fibromata and osteomata have been observed. As a rule, the sclera is only implicated by contiguity with disease in the choroid or ciliary region.

Injuries of the sclera are frequent (see p. 110).

X. CORNEAL ULCERS.

Normally the cornea is clear and transparent; in keratitis it is cloudy. Normally the anterior surface of the cornea *will act as a mirror* and reflect a luminous image; in keratitis this image is lost or broken. Normally there are no bloodvessels in the cornea; in keratitis vessels grow in from the periphery.

The cornea is acutely sensitive, so keratitis causes pain, photophobia, blepharospasm, lachrymation. Since the cornea becomes cloudy, vision is reduced (Figs. 33 and 36).

Fluorescin.—There is no better mode of determining loss of substance of the cornea than by use of this stain. Instil one drop into the eye to be examined ; after a few moments wash out with water. If there be an abrasion or ulcer it will be stained a brilliant green.

There are two classes of keratitis :

1. *Suppurative* : Ulceration from infection, injury, exposure, exanthemata, loss of nerve supply, phlyctenulæ.

2. *Non-suppurative :* Interstitial keratitis, pannus, sclerosis, keratitis profunda.

FIG. 33.—The images of the window upon the cornea as they appear in :
A. Normal health : the image is sharply marked and regular to the curve of the cornea.
B. Keratitis : the image is poorly seen against the general haze which reflects light.
C. Old scarring from ulcers : the image is clear, but distorted.

Chronic Phlyctenular Ulcer.—Of all varieties of ulcers this is by far the commonest, and in this form the subjective symptoms are all marked. The general features of phlyctenulæ have been noted under Conjunctivitis (p. 33).

Amongst cases of phlyctenular conjunctivitis seen at the Belgrave Hospital, 3 per cent. developed a severe relapsing and chronic keratitis, lasting months and even years. The children are usually shockingly ill-fed and ill-kept. The cornea presents one or more deep gutter- or pond-like ulcers ; they are sodden and vascular, and a leash of coarse vessels crosses the limbus to the ulcer. An ulcer may perforate, the iris prolapse, and a leucome adherens result. Vision is always seriously and permanently diminished.

Treatment. — Change the child's surroundings ; if possible

get it to the seaside. Clean it thoroughly, feed it well, and give cod-liver oil and iron. Use atropine and yellow ointment for the eye, and bandage evenly. If the ulcer does not diminish, or if it is very vascular, touch each vessel, just before it passes the limbus to break up into the ulcer, with the actual cautery as lightly as possible, so as to make a minute white scar across the vessel; the sudden stoppage of the

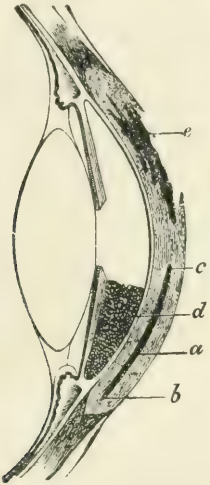


FIG. 34.—*a*, *b*, *c*, Pus in the substance of the cornea (onyx); *e*, deep infiltrating ulcer with undermined edges; *d*, pus in the anterior chamber (hypopyon)—a more common condition than onyx.

abnormal blood supply causes the ulcer to heal rapidly. The results are excellent.

Serpiginous Ulcer (syn., Hypopyon Ulcer) occurs, as a rule, in elderly people, following an abrasion of the cornea by injury, and tends steadily to progress, both in depth and extent. It has been shown to be due to the presence of septic micro-organisms, and particularly the pneumococcus; frequently

there is a chronic septic condition of the lachrymal sac. The following features have to be noted : (1) The ulcer may be either marginal or central, and is usually sinous or curved in outline ; (2) the edge of the ulcer is swollen and raised, and there is extensive infiltration of the cornea around it ; (3) hypopyon is a frequent complication (see Fig. 34, *d*), whether perforation of the cornea occurs or not ; (4) severe pain, photophobia, and congestion of the eye are nearly always present.

Not only are the subjects of serpiginous ulceration of the cornea as a rule elderly, but most cases (especially those not starting in an injury) occur in poor, ill-nourished patients. In such iritis, hypopyon, and even inflammation, and shrinking of the whole eye, may follow ; so every case should be regarded as of grave prognosis, and demanding most careful treatment.

Bacteriology.—Make film preparations and cultures from a scraping of the ulcer edge. Morax-Axenfeld bacillus, staphylococcus, and pneumococcus are most common excitants. The first is readily cured by zinc sulphate drops, ½ per cent. every hour. The last is severe and destructive ; vaccine should be prepared from the culture, and used in conjunction with other measures.

Treatment. — In its early stage the ulceration may be cut short by the very frequent use of warm boracic lotion, or of perchloride of mercury (1 in 5,000). If there be infiltration around the ulcer, it should be cauterized with pheno-camphor, and atropine ointment used. A generous diet and quinine internally are indicated ; and if the pain prevents sleep, a hypodermic injection of morphia may be useful in the evening.

Never fail to examine the lachrymal sac ; and if sepsis be indicated by regurgitation on pressure, it should be combated by dilating the lower punctum and washing out the sac frequently with antiseptic and astringent lotions. If the lachrymal duct be obstructed, it is well to excise the sac at once.

If in spite of this treatment the ulcer spreads, the edge of the ulcer should be cauterized with the galvano or a fine-pointed actual cautery. Or what is known as Guthrie's or

Saemisch's operation performed: this consists in the division with a Graefe's cataract knife of the borders of the ulcer, both puncture and counter-puncture being placed in healthy corneal tissue, and the section (which opens the anterior chamber) is made to traverse the diseased area from behind forwards, crossing the ulcer at its centre; or the incision may be made radially in the lower part of the cornea and directly into the hypopyon. Then the pus in the anterior chamber should be drawn out through the incision with fine forceps. Eserine is dropped in after the section has been made, and mild antiseptic lotions employed. It is remarkable what relief follows this operation in many cases, the ulcer healing in the course of a week or two; but should it not be successful, the wound may be opened daily for a few days with a fine probe, and atropine used instead of eserine. Even if the ulcer heals satisfactorily a considerable nebula will be left; and should this obstruct

Fig. 35.—Snell's platinum cautery.

vision, a subsequent iridectomy for optical purposes may become necessary.

To cauterize Corneal Ulcers with pheno-camphor (p. 173). Stain the ulcer with fluorescin. Wash out excess with cocaine, 5 per cent. Hold the lids open with finger and thumb of one hand; sop up the tears with a pledget of wool or piece of filter-paper, and dry the cornea by the same means. Now go over the whole stained area with a bluntly-pointed match soaked in pheno-camphor. Be particularly careful to stub the liquid into the margin of the ulcer. Each part touched turns white and is anæsthetic. Insert atropine ointment between the lids; cover with pad and bandage. The white eschar is quickly absorbed and replaced by healthy tissue.

For the galvano or actual cautery a general anæsthetic is necessary: stain and dry the ulcer, then burn round the edge, taking the apparently healthy lip. The scar is permanent.

Atropine and Eserine in Corneal Ulcers.—Neither drug has any direct action on the cornea ; both act on the muscles of the ciliary body and iris, and so alter the blood flow and indirectly the nutrition of the cornea. The ciliary body is innervated by the same sensory nerves as the cornea ; irritation of the cornea sets up irritation of the ciliary region, with risk of cyclitis and iritis. But this is not all ; a congested ciliary region means defective removal of venous blood and more or less stasis of the fluid in the anterior chamber, and therefore a poor lymph supply and poor nutriment to the proper substance of the cornea ; the worst possible state in which to repel microbes invading its substance. The indication is to use a drug that will reduce the irritability of the ciliary muscle, and for this purpose there is no better drug than atropine.

On the other hand, eserine produces a tonic spasm of the ciliary muscles, increasing the irritability of the region and liability to iridocyclitis, and the added congestion of the veins tends to retard the circulation of the aqueous. There are occasions, however, in which sluggish, relapsing ulcers have rapidly healed on replacing atropine by eserine ; the change to eserine seems to have supplied just the stimulus required in these cases.

These remarks do not apply where perforation is certain ; then use the drug most likely to keep the iris from prolapsing, atropine in central, eserine in marginal ulcers.

Dendritic Ulcer is a fairly common and relapsing disease. The ulcer is superficial ; it spreads as a greyish line, with many branches and buds (hence the name), which can be demonstrated with ease by staining with fluorescin (Fig. 41, C).

Treatment.—Cauterize with pure carbolic acid.

Ulceration Secondary to Disease of the Conjunctiva.—In the course of purulent ophthalmia the cornea is very liable to ulcerate or slough. This complication is to be feared if, on separating the lids, the cornea is seen to be hazy, and 'like the eye of a dead fish' (Nettleship).

In cases of trachoma the cornea is often involved, either with superficial ulceration or with pannus, or both. Mistakes in

diagnosis are readily made, unless the lids are examined: and unless their inflammation be treated, it is practically useless to treat the corneal ulceration.

Acneiform Ulcers.—In severe acne of the face the conjunctiva and cornea may be inflamed and the latter ulcerated. Treat the general condition by a vaccine prepared from the patient's organism. Eye treatment as for phlyctenular ulcer (p. 52), but applications must be weak, as irritability is excessive.

Bullous Keratitis or recurrent blebs on the site of an old injury are best treated by stripping off the epithelium and painting with silver nitrate, 2 per cent.

Transverse Calcareous Film of the Cornea, opposite the palpebral fissure, occurs in old folk with blind, or nearly blind eyes. If it causes irritation treat by scraping off the film.

Exanthemata.—In all acute facial eruptions there is risk of corneal involvement, either by the eruption appearing on the conjunctiva or by pus from an eruption getting into the sac. In measles and scarlet fever a superficial punctate keratitis is described, and thought to account for the liability to subsequent corneal ulcers. In small-pox there is grave liability to corneal ulceration and subsequent blindness.

Treatment.—Should the conjunctiva be inflamed, irrigate freely with warm boracic lotion. Ulceration should be treated in the same manner as serpiginous ulcer.

Ulcers from Exposure.—In paralysis of the orbicularis palpebrarum the eyelids remain open (lagophthalmia); in severe exophthalmic goitre the lids cannot cover the bulging eyes. In states of coma or semi-coma from typhoid, meningitis, or other severe disease the lids remain partly open and immobile. In all these states the cornea dries, and septic foreign bodies readily cause ulcers. The lids should be stitched together and plentifully lubricated with vaseline.

Trophic Ulcers.—In paralysis of the first division of the fifth cranial nerve, caused by operation for tic, or by injury, or new growth, the cornea loses sensibility. The trophic influence of the nerve is gone, and insensibility increases liability to injury. Ulceration, with loss of the eye, may result. The lids should be

sewn together at inner and outer canthi, and the slit reduced to the breadth of a full pupil.

Herpes Ophthalmicus is due to an affection of the Gasserian ganglion. Disturbance of the nerve nutrition results in changes in the skin area. There is first pain, then numbness, and finally crops of vesicles along the paths of the nerves affected, usually the supra-orbital. The eye is irritable and red; the cornea is frequently insensitive to touch; there may be iritis; rarely vesicles appear on the cornea. Corneal vesicles may also occur in the commoner herpes nasalis febrilis.

Treatment.—Feed well and give quinine in large doses; cover the skin with vaseline or dusting powder; instil atropine into the eye. Morphia injections may be required to allay pain.

Pemphigus.—The cornea and conjunctiva are sometimes implicated in the general disease of the skin. The effects are disastrous; scar tissue forms under the conjunctiva and by contraction gradually obliterates the fornices; entropion symblepharon and blindness are usual.

Treatment.—See Lime Burns, p. 106.

XI. INTERSTITIAL KERATITIS.

This peculiar form of corneal disease generally affects both eyes, though not always at the same time, and is most common between the ages of six and sixteen, though rarely it may develop as early as six months and as late as sixty years. Relapses, though infrequent, are not unknown, sometimes occurring after an interval of many years. Two chief types are met with: (1) A ground-glass opacity of the whole cornea. (2). Vascularity of the substance, the great number of minute vessels giving a red or pink colour. The term 'salmon patch' is applied to the appearance of the cornea in this condition. These two conditions are, however, frequently seen together.

Etiology.—Typical interstitial keratitis is due to inherited syphilis in the vast majority of cases. Rarely it occurs in acquired syphilis. Occasionally it may be due to tubercle, or secondary to a tubercular scleritis, or in the East to a leprous

scleritis. Rarely its onset is dated from an injury; then it may be that the patient is the subject of inherited syphilis and the injury merely determined the particular manifestation.

Inherited syphilis probably accounts for 90 per cent. of the cases of the disease, and the diathesis is usually proved by the

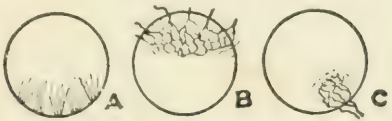


FIG. 36.—Blood-vessels left by various forms of keratitis. (Seen with the ophthalmoscope and × 20 D lens):

A. Interstitial keratitis: fine, brush-like vessels, deep in the substance, may be all round the cornea.

B. Trachoma: in pannus a coarse network of vessels penetrate between the epithelium and Bowman's membrane in the upper quadrant only.

C. Chronic phlyctenular ulcer: an isolated group, of superficial origin.

co-existence of other signs of which Hutchinson's teeth are the most characteristic. The permanent incisor teeth are malformed at their cutting edge. The edge is narrower than the base, so that the tooth is like a screw-driver. Further, the middle of the three cusps of the incisor is lost, so that the tooth is deeply notched in the centre. The deformity may be present in central

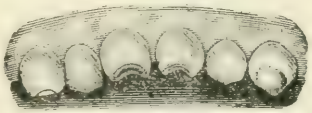


FIG. 37.—Hutchinson's teeth, due to inherited syphilis (permanent set, upper row). Central incisors notched and narrowed at their cutting edge.

and lateral incisors or the canines or bicuspids of either jaw; but (as Hutchinson insists) the upper central incisors are the test teeth of inherited syphilis. Occasionally the first permanent molars are dome-shaped (Moon's teeth). The palate is generally high and narrow (though this malformation is not peculiar to inherited syphilis), the forehead grooved horizontally

just above the eyebrows with a transverse projection above this. The bridge of the nose is often sunk, and radiating scars around the mouth are not uncommon.

About the time the eyes become inflamed a very obstinate form of deafness is liable to develop, and occasionally periosteal nodes are met with on the tibia or other bones. In a small proportion of cases one or both knees become affected with chronic synovitis, comparatively painless, and entirely clearing off after a few weeks or months.

There is generally a history of syphilitic symptoms in infancy (snuffles, rash, condylomata ani, etc.), and the mother has very likely had repeated miscarriages or still-births, and if there are in the family older children living than the patient, they may also have suffered from interstitial keratitis or other suspicious symptoms.

Sometimes, however, interstitial keratitis is the only symptom of the diathesis. The Wassermann reaction should be taken; it is particularly reliable in these cases.

Its course is always slow; the active stage may last from three to six months, and relapses are common. Vision is greatly impaired by the presence of inflammatory exudates and tissue changes within the layers of the cornea. After the cessation of the attack, the cornea tends to clear; if the inflammation has been confined to the interstitial layers vision may be regained; if, however, the deep layers and Descemet's membrane have been involved the scarring is permanent and usually presents a triangular form, apex upwards.

Even when the cornea has apparently cleared, the keratitis may be recognized years afterwards by the presence of numerous fine lines in the cornea, the remains of vessels, detected by direct ophthalmoscopic examination with a high convex lens.

The chief complications are the following: 1. Iritis is frequently present and, since it may be masked by the corneal opacity, the use of atropine is nearly always advisable during the active progress of the disease. 2. Choroiditis—generally of the patchy or disseminated form, but sometimes simulating retinitis pigmentosa. 3. Inflammation of the ciliary region—

leading to secondary glaucoma in some cases, and always gravely affecting the prognosis. 4. Ulceration of the cornea is very rarely met with, but does occur in a few cases.

A not infrequent result of interstitial keratitis is the production of myopia as a consequence of the yielding or slight bulging of the weakened cornea. If the disease is very severe, a more marked yielding may ensue, producing anterior staphyloma. In some cases a glaucomatous condition may arise ; then the anterior chamber becomes very deep, and the cornea oval instead of round ; a condition simulating buphthalmos.

Treatment.—A prolonged course of mercury given in small doses is necessary. It is well to interchange (1) inunction of blue ointment with (2) grey powder given by the mouth, and (3) with the perchloride combined with the iodide of potassium, using one or other mode for a month at a time. If the patient be anæmic, syrup of the iodide of iron should be given intermittently.

Atropine should be used so long as the inflammation is in the active stage to prevent iritis, and a convenient form is the ung. hyd. ox. flav. cum atropia. In a few cases, however, permanent dilatation of the pupil has followed the prolonged use of atropine, in interstitial keratitis, and it is therefore best to discontinue it as soon as possible. The corneal opacity clears very slowly, and sometimes iridectomy is performed, but is rarely required. The increase of tension sometimes present does not indicate this operation unless very pronounced.

When interstitial keratitis occurs in *acquired* syphilis it usually affects one eye only, the symptoms are less severe, and clear up with remarkable rapidity on general treatment with mercurials.

XII. OTHER CORNEAL DISORDERS.

Arcus Senilis.—In some subjects there may be seen just within the corneal margin two crescentic lines of white opacity ; one, usually the more marked, is in the upper part of the cornea, the other in the lower. These lines may ultimately

meet to form a ring, and increase in width so as even to reduce vision. The lines are caused by a deposit of fat in the corneal cells. The patients are usually over fifty years of age, but it is by no means always present in very old subjects; there seems to be a family predisposition to its early development. Frequently it is met with in patients with atheromatous vessels; still, its presence does not materially alter the prognosis of an operation on the cornea—*e.g.*, cataract extraction.

Conical Cornea.—The centre of the cornea becomes thinned and pushed forwards whilst retaining its transparency. In severe cases the conicity may be easily recognized by looking at the eye from the side; long before this can be effected, how-

FIG. 38.—Placido's disc for the detection of corneal irregularities. ($\times \frac{1}{10}$.)

ever, conical cornea may be detected by the use of Placido's disc or retinoscopy.

The images of the rings of Placido's disc seen upon a conical cornea are distorted and drawn to one side, giving an appearance very like the marking on a starch granule. The apex of the cone is usually excentric, downwards and inwards. The retinoscopy reflex presents the features of marked spherical aberration; the light is broken up by the presence of a sharply-defined and deep shadow.

It is most important to recognize the early stages of conical cornea, since it gives rise to irregular astigmatism and considerable defect of vision, with symptoms of asthenopia. The astigmatism may be corrected and the vision improved by suitable glasses. High convex cylinders, even up to 10 dioptres, with

axes nearly horizontal, are usually required ; the refraction is best worked out by means of the stenopaeic slit (p. 126). All close work - reading, writing, or sewing—should be stopped, and a healthy outdoor life adopted. If the condition advances despite these precautions, periodic bandaging of the eyes should be tried ; first one and then the other should be firmly tied up for a week.

As the disease advances opacities tend to appear at the apex of the cone, due to aqueous entering the cornea through cracks in Descemet's membrane, and vision is then greatly impaired ; in such a state interference by operation is justifiable. The summit of the cone may be excised with a Graefe's knife, or cauterized, or trephined with a very small special trephine.

FIG. 39.—The images of the rings of Placido's disc on the cornea as they appear in :

A. Normal health : rings regular and unbroken.
B. Regular astigmatism of 4 D : rings oval.
C. Early conical cornea : rings distorted and displaced down and inward to apex of cone (in higher degrees the rings are much smaller and closer together).
D. Dimpled scar following ulcer : the rings are kinked, and a small secondary image is formed.

In all these operations the anterior chamber is penetrated, and there is risk of an anterior synechia forming ; the pupil should therefore be well dilated with atropine before the operation.

The cause of the disease is obscure ; possibly it is due to a congenital defect in the substantia propria. Generally both eyes are affected, and the patients are most commonly women. The disease occurs in from 1 in 2,000 to 1 in 5,000 of eye patients.

Metallic Deposits in the Cornea.—If a case of corneal ulcer or abrasion is ignorantly treated with lead lotion, a white deposit of a salt of the metal is formed, which persists as a characteristic opacity ; it can be scraped off with some difficulty. Hence the rule never to use lead lotion in any eye case. Nitrate of silver,

if used for long in ophthalmia cases, may produce a brown stain (argyrosis) of the conjunctiva, and possibly of the cornea.

Guttate Keratitis. — A degenerative change in Bowman's membrane, leading to its destruction, and the deposition of hyaline granules in its place. It may be hereditary. Care must be taken not to mistake this for the commoner keratitis punctata of irido-cyclitis (see Fig. 41).

Sclero-Keratitis.—See Scleritis, p. 51.

Keratitis Punctata.—See Serous Iritis, p. 68.

Keratomalacia.—See Purulent Conjunctivitis, p. 26.

Opacities of the Cornea.—An opacity is known as a nebula, macula, or leucoma, according to its density. A leucoma adherens has iris adherent to the scar, and is proof of a previous perforation of the cornea.

If scars obscure vision by their situation, an optical iridectomy may be performed. Unsightly scars may be disguised by

Fig. 40.—Tattooing needle.

tattooing. Cocaine the eye ; cover the scar with thick India ink (sterilized) ; make numerous oblique superficial wounds into the cornea with a grooved needle. The operation has set up cyclitis, so should never be performed on an irritable eye.

XIII. DISEASES OF THE UVEAL TRACT.

The uvea is the middle coat of the eye. In form it is a sphere, open in front at the pupil and behind where pierced by the optic nerve. It has three divisions: iris, ciliary body and choroid. The tissues of these parts are continuous and similar in structure ; there is one blood supply for all, and the sensory nerves of iris and ciliary body are the same (the choroid appears to have none). From these anatomical points we should realize that inflammation of one part of the uvea—say the iris—is sure to affect neighbouring parts to a greater or less

degree. Irido-cyclitis is a good example. In such a case we may see patches of inflammation in the anterior part of the choroid, besides evidences of cyclitis and iritis.

For convenience we consider the diseases as they most evidently affect iris, ciliary body, or choroid.

XIV. DISEASES OF THE IRIS.

Iritis.—It will be remembered that the iris lies immediately in front of the lens capsule, its pigmented or uveal surface resting against the latter (see Fig. 1). In all forms of inflammation of the iris the tendency is to contract adhesions with the lens ('posterior synechiæ'), and often to leave deposits of the uveal pigment upon its surface (Fig. 42, 4). The pupillary margin is the part of the iris in which its capillaries are most plentiful, and hence the inflammatory process is generally most marked at this part. By the use of mydriatics (of which atropine is the strongest) it is possible to draw away the inflamed iris, and so prevent adhesions being formed, or even to rupture those just formed; but the treatment, to be effective, must be commenced early in the case, and used in sufficient strength. Hence the great importance of recognizing the onset of iritis, of which the chief symptoms are the following:

1 The pupil is altered in shape; it may be a little smaller than that of the other eye, and does not dilate so well when the eye is shaded; it is either sluggish or immobile. If homatropine be applied, and the eye examined thirty minutes later, the difference in shape becomes marked, the pupil is irregular, owing to adhesions (Fig. 42, 4). If a circular adhesion exists all round the pupillary border, of course no dilatation takes place, unless the adhesion be of very recent date.

2. The colour of the iris is altered, a greenish tint is the most usual, but an originally brown iris does not change much. In some cases little nodules of lymph are seen, and sometimes minute red streaks (vessels) running towards the pupil. At the border of the pupil, by careful focal illumination, one or more little tags may be seen (synechiæ) fixing the iris to the lens.

These are brown when fresh, and whitish when old. The reticulated surface of the iris is blurred, owing partly to turbidity of the aqueous and cornea, mostly to congestion and effusion of lymph into its substance.

3. There is generally marked congestion of the eye, especially immediately round the corneal margin, and the deeper vessels are involved in this congestion. But frequently the whole conjunctiva is red, and the character of the congestion is by no means a safe guide as to the presence of iritis. A case of early iritis may be mistaken for simple catarrhal ophthalmia, a mistake which would nearly always be avoided by using homatropine and examining for the first-mentioned symptom.

Differential Diagnosis of Iritis.

Acute Iritis.	Acute Conjunctivitis.	Acute Glaucoma.
1. Pupil: small, sluggish irregular after atropine	Normal	Dilated, oval, fixed
2. Iris: swollen, dirty, lymph on surface	Clean and bright	Swollen and discoloured
3. Anterior chamber: normal (or deeper, and aqueous turbid)	Normal	Shallow
4. Cornea: clear (or with deposits on back)	Clear	Steamy; *anæsthetic*
5. Ciliary region: injected	Not injected	Injected
6. Conjunctiva: usually some injection	Red, opaque, perhaps swollen	Great congestion, perhaps chemosis
7. Discharge: tears only	Muco-pus	Tears only
8. Palpation: tension normal (occasionally +1); tender in ciliary region	Tension normal, not tender	Tension + 2 to 3, very tender
9. Pain: over forehead and nose, worse at night	'Sand or grit in eyes'	Intense neuralgia in and about eyes, nausea, vomiting
10. Vision: clouded	Scarcely affected	Rapidly lost; field extremely limited; 'rainbow-rings' seen
11. Disc: if seen, normal	Normal	If seen, cupped, and arterial pulsation
12. Age liability: adults	Children	Elders (40 and over)

4. Besides pain in the eye and more or less photophobia, there is generally pain referred to the forehead or nose. This referred pain is due to the fact that the iris is supplied by the nasal branch of the ophthalmic nerve (long ciliary twigs), and, as a rule, the pain in acute iritis is most intense in the distribution of the supra-orbital division.

These are the cardinal symptoms of iritis which are present in acute cases. In mild cases, however, one or more of them may be very little marked, and in such the action of the pupil to light, and still more to homatropine, is the only conclusive test. The tension of the globe in iritis is not infrequently slightly raised, and the question of glaucoma may be suggested. It is, of course, the worst possible treatment to use atropine in a case of glaucoma, but it is necessary to employ it in iritis, even though the tension be increased.

We have now to consider the causes of iritis. Of these by far the most important are secondary syphilis, and rheumatism or gonorrhœal rheumatism.

1. **Syphilitic Iritis** occurs usually from three to six months after the chancre, and in congenital syphilis at the same date from birth ; it rarely affects both eyes simultaneously, but very often the two in succession. The second eye may become affected although the patient is under full mercurial treatment for iritis in the other eye. It very rarely relapses, and is rapidly improved by thorough mercurial treatment. It is in this form that the so-called gummata of the iris are met with—little pinkish-white nodules, on which new vessels can be made out. They are sometimes single, generally multiple, and tend to form large posterior synechiæ. Lymph in the anterior chamber may accompany them.

Secondary syphilis probably accounts for about 50 per cent. of the total number of cases of iritis. Syphilitic iritis in infants is decidedly rare ; as already mentioned, it occurs within six months of birth, probably in a few cases it comes on *in utero ;* it is much more common in female children than males. The same tendency to free effusion of lymph is seen here as in adults, and the pupil may become occluded by it. Besides these

infantile cases, we have to remember that [illegible] from inherited syphilis may come on at or after puberty. [illegible] complication of interstitial keratitis.

2. **Rheumatic Iritis** is met with in adu[illegible] It usually affects only one eye at a time, and tends to form fi[illegible]l [illegible]sions, but not to develop nodules of lymph; it very frequently relapses. Its subjects are generally those with a hist[illegible] of rheumatic or 'gouty' symptoms, in which lumbago [illegible] included; and the iritis is often brought on by exposure [illegible] or cold. The congestion, photophobia, and pain are all [illegible] severe than in syphilitic iritis; but the tendency to relap[illegible] perhaps the best-marked feature. In some cases the diagn[illegible] difficult between the two forms, and it must be based on t[illegible]nsideration both of the symptoms and the previous his[illegible] of the patient. Many deny the existence of a pure 'r[illegible]atic' iritis, and believe that this iritis only follows gonorrh[illegible] rheumatism. To recapitulate the chief points in the differe[illegible]l diagnosis:

Syphilitic Iritis.	*Rheumatic Iritis.*
1. Frequently small nodules of lymph present.	1. Tend to produce tough adhesions without nodules of lymph.
2. History of secondaries within about six months of the attack, or presence of syphilitic symptoms.	2. History, perhaps, of previous attacks, or of rheumatic symptoms
3. Does not tend to relapse.	3. Pain, congestion, etc., very severe
	4. Frequent relapses.

3. **In Gonorrhœal Iritis** there is the same tendency to frequent relapses. The ciliary region may be involved, so that dusky patches of congestion and exudate are seen in this part (cyclitis, or scleritis). In other respects it is closely allied to rheumatic iritis, and its subjects are nearly always those with gouty or rheumatic tendencies. In such a patient every attack of gonorrhœa may be complicated with iritis.

4. **Serous Iritis**, or **Irido-cyclitis**, is extremely slow in progress, and characterized by the deposit at the back of the

cornea of a number of little whitish dots of lymph, which cover a triangle, with the base downwards and the apex towards the centre of the cornea, **keratitis punctata.** These dots are the leucocytes extruded from the inflamed ciliary body, and gathered into clumps by the shrinking of the fibrin coagulating about them; they are deposited on the cornea when they are washed through the pupil into the anterior chamber. The dots may persist for months or never wholly disappear. The pupil is slightly enlarged, tension raised, and anterior chamber deepened. Vitreous opacities, peripheral choroiditis, and bleaching of the iris are common. One or both eyes may be affected.

Usually its subjects are working girls; they are anæmic or

FIG. 41.—Spots in or on the cornea:

A. Keratitis punctata: small precipitates on back of cornea in irido-cyclitis.
B. Keratitis punctata: large 'mutton-fat' precipitates in irido-cyclitis (note the granuloma of the iris).
C. Dendritic ulcer in surface epithelium (p. 56).
D. Guttate keratitis: spots of hyaline degeneration in Bowman's membrane (p. 64).
E. Section of cornea to show keratitis punctata (*vide* A and B).
F. Section of cornea to show guttate keratitis (*vide* D).

run down in health, there may be glandular enlargements in the neck, and it is very common to find septic teeth or pyorrhœa alveolaris, and chronic constipation.

Serous iritis may occur as a symptom of sympathetic disease (p. 112), or occasionally in rheumatic subjects.

5. **Gouty Iritis.**—This, though a rare disease, deserves notice from its peculiar features. It is very insidious—*i.e.*, pain and congestion may be but little marked, but the ciliary body is inflamed at the same time, so that the eye is often very seriously impaired, apart from the formation of iridic adhesions. It may come on quite early in life, and though the

patient may never have had any other gouty symptom, there is a history of gout in the parents.

6. **Tubercular Iritis.**—This is most frequently seen in children and young adults. It is of a quiet, painless, and chronic type. Miliary tubercles are to be seen in the iris—small greyish nodules, with a few pink vessels about them. They usually appear at the root of the iris, close into the angle of the anterior chamber, but may affect the border of the iris. Spots of lymph of large size, like spots of mutton fat, may be seen on the back of the cornea, indicating cyclitis (Fig. 41, B).

In other cases these symptoms may be complicated by a sclero-keratitis; these are of a more severe order, and shrinkage of the eyeball may result.

The diagnosis of tubercle is not easy. We may exclude syphilis by history, by the balance of stigmata, by the Wassermann reaction, and by the response to treatment. The reaction to injection of Koch's tuberculin or the newer Von Pirquet's or Moro's skin reactions* may be utilized, or the aqueous may be tapped and inoculated into rabbits.

7. **Traumatic Iritis** is met with after penetrating wounds of the cornea and iris, sometimes after cataract or other operations on the eye. It presents nothing peculiar in its symptoms.

8. There are cases of iritis recorded due to many other conditions, even such simple ones as mumps and over-fatigue. It is evident, therefore, that the iris and ciliary body are particularly susceptible to react to poisons present in the body.

Results of Iritis.—If a severe case of iritis be neglected, blindness is liable to result from the blocking of the pupil with lymph (occlusion), or from the formation of total posterior synechia (exclusion). In the latter case, the fluid in the

* Von Pirquet's reaction is obtained by lightly scarifying the epidermis on a convenient place—say the forearm—and rubbing in a 25 per cent. solution of Koch's original tuberculin; if papules form, the reaction is positive (a control scarification which is not inoculated should be made). Moro's reaction is obtained by rubbing vigorously into the skin of the belly an ointment of tuberculin and lanoline; the formation of papules is a positive indication. Neither reaction is very reliable. Calmette's ophthalmo-reaction should not be employed; it has been known to set up dangerous keratitis.

two chambers does not circulate and escape in the normal manner; the outer part of the iris becomes bulged forwards (*bombé iris*), and secondary glaucoma may supervene. Even if thoroughly treated, iritis will probably leave slight impairment of vision owing to uveal deposit on the lens, etc., but in some cases the recovery is almost perfect. The most obstinate forms are serous iritis, that due to inherited gout, and sympathetic iritis.

Treatment.—In all cases, without exception, use atropine so long as the attack is in an active stage. A solution of atropine sulphate, 1 per cent., should be applied every two hours the first day or two, and less frequently afterwards if the adhesions yield. The strongest known mydriatic is a combination of atropine and cocaine (2 per cent. of each), and the surest way of having it thoroughly applied is to use it as an ointment made up with equal parts of vaseline and lanoline, inserting a little of the ointment within the lids. Occasionally atropine irritates, increasing the congestion, and causing some swelling of the lids and eczema round them. These cases are very exceptional; in them sulphate of daturine (2 grains to the ounce), or sulphate of duboisine (1 grain to the ounce), or hydrobromate of hyoscine (2 grains to the ounce), may be tried instead of the atropine. After an attack has passed off, it is worse than useless to persist with mydriatics in the hope of breaking down old adhesions, as they may then produce irritation and congestion of the eye.

A brisk purge is advisable in commencing the treatment of any acute iritis.

Stimulants should be forbidden, and the eyes should be kept at rest by means of a shade or confinement to a darkened room. (In serous, or tubercular iritis, or where one eye only is affected, the latter measure is unnecessary.)

The pain of acute iritis may be severe; it is generally relieved to some extent by atropine, but hot fomentations frequently renewed are most comforting. If, in spite of these measures, the pain persist, the application of a couple of leeches close to the outer canthus is of great benefit, or blistering the

temple may be tried, and morphia or chloral given at night-time in order to obtain sleep. Dionine, 5 per cent. in water, instilled with the atropine has in some cases proved very effective in relieving the pain.

In *Syphilitic* iritis the patient should be brought thoroughly under the influence of mercury, either given internally (hyd. c. cretâ, 2 grains, pulvis ipecac. comp., 1 grain, thrice daily in pill ; or blue pill ; or the liquor hydrargyri perchlor. in 1-drachm doses) ; or by inunction of blue ointment, or intramuscular injection of calomel in olive oil. Probably the internal administration of grey powder is the most convenient and as efficacious as any. If the gums become touched, the dose of mercury should be diminished, and a weak solution of chlorate of potash, or of carbolic acid and rectified spirit, used as a mouth-wash. The use of salvarsan should be considered.

In *rheumatic* iritis the application of warm, dry heat by means of cotton-wool and a bandage, or with a piece of heated brick in the wool, is comforting. When the arthritic tendency is present salicylates or aspirin are invaluable.

In *gouty* iritis dry heat is also valuable, and colchicum may do good. In the obstinate cases of relapsing irido-cyclitis due to hereditary gout probably nothing will be found to effect a cure except change of climate ; a warm, dry one, such as some parts of New Zealand, is best.

Traumatic iritis is the only form in which the cold pack may be employed, and then only at its outset ; even then the cold must not be so intense as to cause pain, nor must it be continued too long.

In *serous* iritis with anæmia give iron and cod-liver oil, have the teeth carefully attended to, relieve constipation, and endeavour to improve the general health by an outdoor life.

In *tubercular* iritis the treatment of the diathesis is the best mode of relieving the eye. Occasionally a judicious use of tuberculin (B.E.) will effect a cure. Residence at the seaside is a singularly effective measure.

Vaccine Treatment.—When a definite diagnosis has been made in irido-cyclitis and a vaccine can be prepared from the patient's

own organism or an appropriate stock preparation secured, this line of treatment should certainly be tried; in some cases valuable results have been obtained; but other measures, such as the use of atropine, should not be stopped.

If, in spite of treatment, many firm adhesions remain, and especially if complete posterior synechia, with increase of tension, be present as the result of iritis, an upward *iridectomy* is usually indicated. The operation, however, is often rendered difficult by the iris having become soft, or 'rotten,' as well as by the fact of the adhesions, and sometimes the artificial pupil again becomes closed by firm lymph. It used to be thought that adhesions in themselves led to relapses of the iritis, and that to prevent the latter an iridectomy was necessary, but this

FIG. 42.—Irregularities of the iris:

1. Iridodialysis: the ciliary processes and lens border and ligament are exposed.
2. Congenital coloboma of right eye.
3. Persistent pupillary membrane.
4. Results of iritis: posterior synechiæ, uveal pigment on lens capsule; the pupil is dilated as much as possible by atropine.

view is now doubted. However, it is quite justifiable to perform the operation in cases of rheumatic iritis in which relapses are frequent, and it would seem to have some influence in preventing them, as well as exclusion and occlusion of the pupil. Iridectomy, however, should not, as a rule, be performed on an eye so long as it is inflamed, but in an interval between the attacks. In cases of old iritis, and interstitial keratitis too, it is sometimes followed by an improvement of vision, especially if the artificial pupil can be formed behind a comparatively clear part of the cornea. Here again, however, the operation should not be done whilst the eye is inflamed, but only when the adhesions of the iris and the corneal opacities are obviously permanent.

In irido-cyclitis, where there is much keratitis punctata, it is good practice to perform *paracentesis* of the anterior chamber and allow the aqueous to escape ; frequently the spots clear up rapidly after the operation.

Tumours of the Iris.—The iris, like other parts of the uveal tract, is occasionally the seat of melanotic sarcoma ; curious cystic formations have also been met with ; and solitary tubercular granuloma occurs. These affections are too rare to require further notice here.

Persistent Pupillary Membrane.—Small tags, connecting the *anterior* surface of the iris with the lens, or bridging the pupil. They are very elastic, unlike the tough inelastic posterior synechiæ of inflammation, which unite the *free* edge of the iris to the lens (Fig. 42).

Coloboma of Iris.—An aperture or deficiency in one part of the iris, which may be the result of an iridectomy, or may be congenital. If the latter, it is usually, but not always, symmetrical, and is situated at the lower part of the iris, this being the last part of the iridic circle to close in its development. It may only involve the pupillary margin, or only the ciliary margin, in which case there is a double pupil. A complete coloboma always becomes narrower towards the ciliary margin. Sometimes there is a corresponding coloboma of the choroid, seen by the ophthalmoscope as a white patch of exposed sclerotic ; but this is much rarer than the cases of congenital cleft in the iris.

Iridodialysis.—Detachment of the ciliary border of the iris, usually due to injury, sometimes to an accident in operation.

Aniridia.—Absence of iris ; the ciliary processes and lens ligaments are exposed to view. The iris may be detached by injury or operation. It may be a congenital deficiency, but minute tags or crescents of iritic tissue are usually present. In congenital cases vision is defective and there is nystagmus.

Iridodonesis (*lit.*, Shaky Iris).—When the iris has lost the support of the lens by removal or dislocation, it trembles with every movement of the globe. The anterior chamber is also deeper than normal.

Heterochromia Iridis.—Different coloured or parti-coloured irides When a congenital anomaly it is of no significance. Occasionally after irido-cyclitis there is permanent loss of colour in one eye; even the lashes may be bleached.

Albinism.—Some children are born with bodies devoid of pigment. The hair of the scalp, of the eyebrows and eyelids, and of the body, is white. The iris has a pale bluish tint; it has no backing of uveal pigment, so that the light enters the eye too freely, and is reflected from the fundus so as to give a pink colour to the eye. The choroid is also lacking in pigment. The vision is always defective and there is nystagmus.

XV. GLAUCOMA.

The essential feature of this disease is an increase of tension of the globe, due to obstructed filtration of fluid from the eye. In the normal eye there is a constant supply of lymph (1) from the vessels; (2) from the glands of the ciliary body. The fluid flows from the posterior chamber forwards through the suspensory ligament of the lens and round the iris into the angle of the anterior chamber, and thence by (*a*) escape through the spaces of Fontana into the canal of Schlemm; (*b*) absorption from the anterior surface of the iris, and thence into the supra-choroidal veins. Thus a sort of equilibrium is kept up, yet the tension of an eye will vary very slightly from time to time (Fig. 1).

Conditions Predisposing to Glaucoma.—1. Sclerosis of the fibres bounding the spaces of Fontana, a change progressive with age (T. Henderson).

2 Increase of the size and bulging forward of the lens with age (Priestley Smith).

3. Unusually small corneæ, in which factors 1 and 2 become particularly important. (Average corneal diameter 11·6 mm.)

Further, glaucoma is more common in eyes with a firm, unyielding sclera (elderly patients, especially those previously hypermetropic) than those with a yielding one (myopic eyes).

Conditions Starting an Attack of Glaucoma.—1. Loss of balance between inflow and outflow, either by altered quantity or quality of ciliary secretion.

2. Congestion of the ciliary region, impeding escape into the bloodvessels.

3. Reaction of 1 and 2 on the iris, thrusting it forward, so that its root covers and blocks the spaces of Fontana; or

4. Use of mydriatic, producing same effect.

If glaucoma comes on apparently spontaneously, it is called *primary* (nearly all cases of acute glaucoma are primary); if following some other disease of the eye, it is said to be *secondary*. Amongst the causes of *secondary glaucoma* are: 1. Traumatic cataract, in cases where the lens swells up rapidly. 2. Dislocation of the lens, where it presses on the ciliary region. 3. Severe iritis, followed by occlusion or exclusion of the pupil. 4. Intra-ocular tumours. 5. Cyclitis (inflammation of the ciliary region), or irido-cyclitis, such as is occasionally due to inherited syphilis. 6. Sympathetic inflammation.

Glaucoma is divided into the acute and chronic forms, typical cases of which differ widely; but intermediate stages are met with, and it is not uncommon for a chronic case to have acute or subacute attacks. Acute glaucoma is much more common amongst women than men, and about 75 per cent. of the total number of glaucoma cases are met with between the ages of forty and seventy years, so that glaucoma is chiefly a disease of middle or old age.

Ætiology of Primary Glaucoma.—1. An inherited tendency is observed in some cases, such as in subjects with small corneæ. 2. The advance of life. We may almost speak of the period after forty years of age as the 'glaucomatous period'; this may be connected with sclerosis of the spaces of Fontana and with the increase in size of the lens. 3. Vaso-motor disturbance caused by excessive use of the eyes, leading to congestion; prolonged strain, as in night-nursing, etc., grief, or mental emotion, especially if the patient weeps or frets much; or sudden mental shock; are all circumstances which may bring on an attack in a patient predisposed to glaucoma. 4. Altered

quality of ciliary secretion. There is certainly a connection between gout and glaucoma, and it will be found that acute glaucoma is especially frequent in the autumn as the cold weather comes on, and the patient's change of diet and habits renders him liable to an attack of either acute gout or glaucoma. 5. The use of atropine, homatropine, or even of cocaine, in elderly patients has occasionally been followed by acute glaucoma, and hence these should be avoided if possible, or their effect speedily neutralized by eserine. The reason is to be found in the mydriatic causing the iris to obstruct filtration by forcing it up into the angle of the anterior chamber.

Symptoms of Acute Glaucoma.—Often there are premonitory signs, of which the following are the most important: Rapid increase of presbyopia, attacks of passing congestion, pain and dimness or 'fogginess' of vision, haloes or coloured rings seen when looking at a distant light. Finally: when acute glaucoma develops, the vision suddenly becomes much worse, even to complete blindness; there is very severe pain in the eye and head, with frequently a feeling of sickness or actual vomiting. The eye presents the following features: Congestion of the globe and lids, with perhaps chemosis. The cornea is frequently anæsthetic to the touch of a wisp of cotton-wool; it is dim or steamy, and may obscure the iris. The anterior chamber is generally very shallow, but this is not constant. The pupil is moderately dilated and fixed, or acts but very slightly to light or shade. The lens looks turbid or greenish. If the fundus can be seen there is a depression (cupping) of the whole disc; the veins are engorged, and there is arterial and venous pulsation. The tension is raised, often the globe cannot be indented at all, then T = + 3. The visual field is found to be much narrowed, its inner side going first, and the patient generally himself notices this narrowing, being unable to see objects unless held in a line with his eye. Even if the loss of vision be almost complete, the narrowing of the field may still be recognized by moving a lighted candle in front of the patient as he looks straight forwards.

Diagnosis.—The importance of remembering the signs given above is very great, as an error of diagnosis is often made during the first few days, when immediate treatment can alone be expected to restore the sight. The headache and sickness may be thought to indicate merely a 'bilious attack,' or the congestion of the ciliary region and dimness of the media may be held to show iritis, and atropine be used with disastrous effect; or the chemosis and slight watery discharge may lead to the diagnosis of acute conjunctivitis. The one essential test is the estimation of the tension of the eyeball (see table, p. 66).

Treatment may be summed up in one word—iridectomy. In a severe acute case the necessity should be urged on the patient of an immediate operation, which, if possible, should be performed under an anæsthetic, the wound being made peripheral in the upper part of the sclero-corneal junction, and a considerable piece of the iris excised (see Operations—Iridectomy for Glaucoma, p. 195). The high tension of glaucoma when unrelieved tends rapidly to destroy the functions of the retina and optic nerve, and hence, after acute glaucoma has existed some time, sight will not be regained even if the tension and pain are lessened by an operation. The urgency for operation in acute glaucoma is as undoubted as in strangulated hernia. Iridectomy acts by: 1. Freeing the blocked spaces of Fontana when the iris is torn clear from its root. 2. The cut edges of the iris never heal up; fluid passes directly through the spaces in the raw edges into the sclero-choroidal veins. Hence it is important to get the cuts through healthy iris. 3. A badly done iridectomy—*i.e.*, where the sclero-corneal wound does not heal perfectly white, but contains uveal pigment or fragments—gives better results in the permanent relief of tension than an iridectomy which from a cosmetic standard is perfect. In the former aqueous may exude through the wound under the conjunctiva.

Where a considerable tag of iris is involved in the wound, a '**cystoid scar**,' or a small black bleb of iris tissue covered by conjunctiva, results. Tension is relieved, but the

scar is unsafe ; it may cause irritation and cyclitis, or it may enlarge dangerously under pressure from within the eye.

Palliative Measures.—If the patient will not consent to an immediate operation, eserine should be used. A solution of 1 to 2 per cent. of eserine in water (to which cocaine may be added—2 per cent.) should be applied very frequently, and the eyes should be protected from light. Pilocarpine (1 per cent.), like eserine, diminishes tension and contracts the pupil, but its effects are less marked as a rule. Leeches to the outer canthus, hot fomentations and purging, help these actions. Paracentesis of the cornea (pricking it towards the outer border with a broad needle and letting out the aqueous humour) is of temporary use. Of these adjuvant measures the use of eserine is the most important, but all of them are quite secondary in value to early iridectomy.

Prognosis.—The rapidity with which complete and permanent blindness comes on in untreated cases varies much, and so long as there is perception of light left in a case of acute glaucoma iridectomy should be tried. But when vision in the affected eye has been wholly lost for some time, the operation will, as a rule, merely relieve the pain, etc., without restoring the sight.

If done early and a satisfactory iridectomy be obtained, the results are generally very good. The patient may regain perfect vision, when the astigmatism resulting from the operation is corrected ; and the tension may remain normal.

In a few cases free retinal or vitreous hæmorrhages follow the sudden relief of tension by iridectomy ; in a few others the lens is wounded during the operation, especially if a keratome be used, and cataract ensues. There is an appreciable risk of staphyloma and of sympathetic inflammation after the operation, and in some the glaucomatous symptoms recur. If the latter happens, or if the tension remains rather full, a careful trial of eserine may be made ; and if this fails, a second iridectomy may be tried. The chance of cure, or even improvement, in these cases of severe recurrent glaucoma is but small, and if the eye becomes both blind and painful, excision of the globe is the best treatment.

Symptoms of Chronic Glaucoma.—In this the congestion of the conjunctiva and sclerotic is comparatively slight, or may at times be quite absent; but if the glaucoma has existed for long, there is a greyish-blue ring seen just behind the cornea, due to thinning of the sclera, and there may be slight bulging at this spot.

FIG. 43.—Cupping of the optic disc;
N. The normal physiological cup.
A. The shallow cup of atrophy of the nerve.
G. The deep cup of glaucoma, particularly chronic glaucoma.

The media are usually perfectly clear, so that a good view of the fundus can be obtained if the lens has not become cataractous; the pupils react to light, though sluggishly, so long as the sight is retained, and there may be very little pain during the progress of the disease. The tension of the

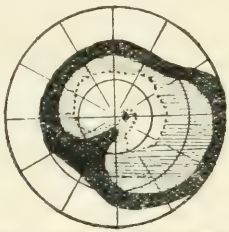


FIG. 44.—Field of vision of right eye in chronic glaucoma. The black indicates total loss of vision; notice the sector pointing to the blind spot. The shading indicates relative loss of perception to Bjerum's test; notice the sector extends to and surrounds the blind spot.

globe varies much from time to time, and the anterior chamber may be deeper than normal. The three most diagnostic symptoms are: (1) The state of the disc: Cupping; sudden bending of the vessels as they emerge from the cup; pulsation of the veins and sometimes of the arteries, especially on slight pressure on the

globe; greyness of the nerve from atrophy. (2) The narrowing of the visual field as taken with a perimeter. The field for white may be concentrically narrowed; its nasal part may be limited or absent, or there may be considerable irregularity in the outline from the loss of sectors of the field. (3) Increase of the size of the blind spot, particularly if this normally small area is extended as a narrow crescentic band either above or below the fixation-point (Bjerum's test, p. 11).

Vision, both near and distant, tends steadily to deteriorate, though in some cases many years may elapse before it completely goes, and in a few it remains almost stationary. Frequently there is a history of transient but repeated attacks of loss of vision. Rainbow-rings seen round a distant light, throbbing in the globe, headache, and attacks of 'mist before the eyes,' are frequent symptoms. The most prominent differences between acute and chronic glaucoma may be recapitulated in a table:

	Acute Glaucoma.	Chronic Glaucoma.
1. Conjunctiva, etc.	Great congestion, perhaps chemosis	Congestion slight or absent; bluish circumcorneal ring in old cases
2. Cornea	Steamy, anæsthetic	Clear, sometimes anæsthetic
3. Pupil	Dilated, oval, fixed	Normal, sluggish or slightly dilated
4. Anterior chamber	Shallow	Generally normal or deep
5. Media	Usually very hazy	Clear
6. Disc	Cupped somewhat; arterial pulsation	Pale, deeply cupped vessels bent at edge, pulsation
7. Field	Vision rapidly lost; field extremely limited	Gradual peripheral loss; blind sectors nasal side; extension of blind spot
8. Tension	+ 2 to 3, very tender	Slightly raised, varies
9. Pain	Intense	Discomfort
10. Onset	Sudden	Insidious

Treatment of Chronic Glaucoma.—Iridectomy, which is so satisfactory for acute glaucoma, gives poor results in chronic glaucoma, perhaps because in such eyes the iridectomy is performed so precisely that healing of the sclero-corneal wound is easy and perfect. Further, a surgeon hesitates to do so large an operation as iridectomy upon an eye which, though harder than normal, may retain $\frac{6}{6}$ vision, with only a slight contraction of the field.

In recent years several operations of lesser severity, which aim at producing a permanent 'filtration cicatrix,' have been devised. All are based on Lagrange's sclerectomy, the cutting out a small piece of sclera at the limbus. The interference with the eye is small, no general anæsthetic is required, and the results up to date are all that could be desired. Tension is permanently reduced; vision is improved both in acuity and field.

After the successful performance of this operation, the site of the scleral opening presents a small bleb of œdematous conjunctiva, due to the escape of aqueous from the anterior chamber through the sclera into the subconjunctival tissue; the bleb *dimples to the touch of a probe*, and varies in size as transudation varies. Rarely infection of the interior of the eye has been known to take place through the flap, for the conjunctival covering seems to afford a sufficient protection. Sometimes the eye becomes too soft (hypotony).

Palliative Measures.—The avoidance of anything likely to cause congestion of the eyes, careful attention to the patient's health, avoidance of stimulants and regulation of diet if gout be present, and the routine use of eserine drops ($\frac{1}{2}$ grain to 2 grains to the ounce, applied once or twice daily), or of pilocarpine, are the chief measures of treatment. In some cases the patient is obviously anæmic or out of health, and tonics may do good. The bowels should be kept regular in action.

Prognosis.—As a general rule, the younger the patient the worse the prognosis.

In both acute and chronic glaucoma, if one eye has been affected there is considerable risk of the other being glauco-

matous also, and a good many cases are symmetrical from the first.

Secondary Glaucoma.—The prognosis is worse than that of primary. Some cases (*e.g.*, due to tumour, old dislocation of the lens, relapsing cyclitis) can only be treated by excision of the eye. Where it follows iritis and *bombé* iris, it can be successfully treated either by iridectomy or by transverse paracentesis of the anterior chamber, with multiple puncture of the iris.

Buphthalmia.—Infantile glaucoma. The name (ox-eyed) indicates the characteristic appearance of these children ; cases are not common. The eyes are harder than normal, highly myopic, and frequently there are deep opacities in the cornea due to splits in Descemet's membrane. Most cases go blind sooner or later. The cause is uncertain : some believe that it is due to a defect in the development of the iris, or of Schlemm's canal ; others, that it is the result of an early or intra-uterine cyclitis. Operative treatment by iridectomy is of no avail ; sclerectomy is moderately successful in some cases ; eserine to the eye and grey powder internally are palliatives.

XVI. DISEASES OF THE CHOROID.

It is often impossible to draw any line between choroiditis and retinitis, both layers being affected by the inflammatory change ; but in some cases the deep pigmentation and sharp outline of atrophic patches, over which the retinal vessels are seen to run, makes it certain that the choroid is chiefly or solely involved.

Choroiditis may be either central—*i.e.*, situated at or near the macula—or peripheral ; there may be one or two large patches or multiple small ones (disseminated). Central choroiditis may greatly affect the vision, but peripheral changes may not interfere in the least with sight, and the surgeon frequently discovers them in eyes which the patient states have 'never had anything the matter with them.'

The chief varieties are the following:

1. Central Atrophic Choroiditis—in large patches round the disc and about the yellow spot—associated with high myopia, posterior staphyloma, often vitreous opacities, and sometimes with large pigmentary remains of hæmorrhages.

2. **Central Retino-Choroiditis.**—When the fundus is examined by the direct method, there may be seen a number of small white dots about the macula, due to atrophic changes (Tay's choroiditis). There is considerable defect of sight, but the disc is normal. In other cases the macular region looks as though it had been dusted over with black pepper. The causes are obscure, and the treatment very unsatisfactory. The pigmentary change sometimes appears to be syphilitic; the atrophic form is a senile change.

3. In contrast to the very fine changes mentioned in No. 2, larger patches of choroiditis are sometimes seen about the disc and macula, and if not due to myopia (see No. 1), are not infrequently syphilitic.

The more typical and really common form of choroiditis due to syphilis is that which is seen in disseminated patches scattered about the periphery. This disseminated choroiditis may affect one, but usually both eyes, and is especially noticed in connection with inherited syphilis. The sharply outlined patches of choroidal atrophy with black borders are very characteristic of syphilis, though not in all cases conclusive evidence.

Finally it may be mentioned that, since most cases with choroiditis come under notice long after the active inflammatory stage is past, treatment is of very little use; if, however, the sight is deteriorating, and there is other evidence of syphilis, iodides of potassium and iron should be given a prolonged trial.

In other cases, such as the myopic form, tonics, rest of the eyes, and the careful avoidance of any work trying to them, with the use of protective tinted glasses, are the measures to be recommended.

Other Diseases of the Choroid.—Tubercle is occasionally met

with, usually in children with general tuberculosis, especially tubercular meningitis. Scattered roundish pale elevations are seen in various parts of the fundus, each patch being rather smaller than the optic disc, which may at the same time be inflamed.

In cases of irido-cyclitis (p. 68) patches of exudation or degeneration can frequently be detected in the periphery of the choroid.

The chief **tumour** of the choroid is a sarcoma, which is often deeply pigmented (melanotic sarcoma). The spindle-celled variety is twice as common as the round-celled in this situation, and pigmented sarcomata are eight times more frequent than the white ones. The tumour may commence at any age, even in the senile period (contrast with glioma of the retina, which is nearly always met with in children). It pushes the retina in front of it, being noticed as a rounded prominence behind the lens, and tending to fill the whole eye. The tension is usually raised, but not invariably. The vision is more or less affected, according to the extent to which the tumour bulges in front of the central area of the retina, when the mass is situated in the anterior part of the globe.

Transillumination should be resorted to. Special small electric lamps within convenient holders are made, which may be placed in direct contact with the globe. The coats of the normal eye are translucent, so light enters the eye and can be seen through the pupil. A simple detachment of the retina is translucent; but a new growth excludes the light, and the pupil remains black.

The rate of growth is often rather slow, but after existing some months to a year or two the sarcoma grows through the sclera and invades the orbital tissues. But perhaps before this has taken place secondary deposits have been formed in the liver or other viscera.

Treatment.—As soon as the tumour is positively diagnosed, the eye, with the whole of the nerve, should be excised.

XVII. DISEASES OF THE VITREOUS.

The vitreous fills the posterior chamber of the eye, keeping the retina in place and supporting the lens. It looks like clear jelly, but the microscopy shows it has structure: a fine enclosing membrane, the hyaloid, and a reticulum which holds the liquid of the jelly. In the fœtus it is opaque from the masses of cells, and has bloodvessels. In the adult it is transparent, has only a few cells in the periphery, and no bloodvessels. The vitreous is nourished by the aqueous secreted by the ciliary body.

Muscæ Volitantes.—Dots, threads, chains of bright spots or comet-like bodies, are seen and complained of by sensitive patients. Every vitreous has imperfections due to remnants of fœtal cells; these cast shadows on the retina which are seen. With the movement of the eye they are jerked upwards, then they slowly sink downwards. The opacities can be made apparent by looking at a white sky or ceiling through a stenopæic disc (p 125): they are evident in the field of the microscope when working with the high powers, and have been mistaken for mobile organisms! Every eye has these dots, but not all see them. They are more noticed by myopes than others, and increase in size of known spots may be observed by the patient after illness or heavy work. So long as the opacities cannot be seen by the surgeon with the ophthalmoscope (using + 10 D lens), the patient may be reassured; if actual opacities can be seen, the condition is pathological.

Opacities.—Vitreous opacities that can be seen with the ophthalmoscope are due mainly to (1) exudates coming from inflammation of the choroid or ciliary body; (2) hæmorrhages from the retina or choroid; (3) foreign bodies.

1. In any inflammation of choroid or ciliary body turbid lymph is exuded; since the aqueous flows from the ciliary body through the vitreous, the turbidity affects the vitreous (p. 69). These deposits seriously affect vision, and, since the metabolism of the vitreous is of the slowest, the injury is lengthy. Treatment must be directed to the primary condition. The metabolism of the vitreous can be hastened by drinking large quantities of bland fluid, and by such alteratives as iodides; subconjunctival injections of saline solution (5 per cent.) may be tried.

2. Hæmorrhages may be due to injuries of the membranes, or arise spontaneously in diseases of the membranes, in choroiditis, myopia, and arterio-sclerosis. There are rarer causes, such as vicarious menstruation, and equally abnormal bleedings in young men. Small hæmorrhages are slowly absorbed; larger ones may lead to growth of scar tissue and 'retinitis proliferans'; severe ones lead to shrinkage of the eye.

3. Foreign bodies from accidental injuries are dealt with in Chapter XX. Rarely a dislocated lens may be seen at the bottom of the posterior chamber like a large pearl. Still more rarely parasites (filaria or cysticercus) may be found in the vitreous.

Synchisis Scintillans.—With age the jelly becomes more fluid. Occasionally crystalline bodies, cholestrine, etc., are deposited within it. Their deposition causes an extraordinary appearance to examination with the ophthalmoscope; there is seen a brilliant display of 'golden rain,' as the light is sharply reflected from the plate like crystals. Often vision is little, if at all, affected, and the condition may be found in one eye only.

XVIII. DISEASES OF THE OPTIC NERVE AND RETINA.

Optic Neuritis.—Inflammation of the optic disc (papillitis or choked disc) is not a disease in itself, but is a symptom of some other primary condition which must always be sought for.

It is characterized by hyperæmia, swelling of and exudation in the disc, with more or less involvement of the surrounding

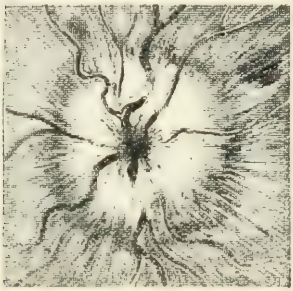


Fig. 45.

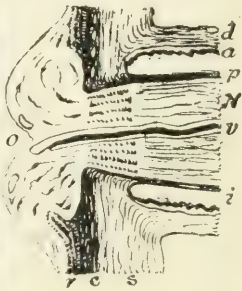


Fig. 46.

Fig. 45 shows the appearance of the disc in acute neuritis, as seen with the direct ophthalmoscope. There is much swelling and exudation; the vessels are swollen and in parts obscured; the dark patches at the upper corners are hæmorrhages.

Fig. 46 shows a section of such a disc. (× 10.) *o*, The swollen nerve-head pushing aside (*r*) the retina; *c*, choroid; *s*, sclera; *N*, optic nerve; *v*, central vessels; *d*, *a*, and *p* are dural, arachnoid, and pia sheaths of nerve; *i*, intervaginal space greatly distended.

retina (especially the anterior or nerve-fibre layer). With the ophthalmoscope one notices (1) blurring of the disc margin, with generally some radiating striation, and in some cases small extravasations of blood; (2) the vessels bend abruptly over the swollen edge of the papilla; (3) they are swollen, tortuous, and perhaps in parts obscured by lymph. The swollen optic disc can be best seen with a + lens in the ophthalmoscope, and supposing the patient to be emmetropic, the degree of swelling

may be measured by the highest convex lens with which the details can be made out. The retinitis, which often accompanies neuritis, is indicated by a haze of that part of the fundus nearest the disc, by the presence of whitish streaks, dots, or patches, especially in the neighbourhood of the yellow spot, by perivascular lines of white colour, and by hæmorrhages, generally linear or flame-shaped.

The whitish patches alluded to are due to œdema of and exudation into the retina, and may clear off to a large extent with the lapse of time; the hæmorrhages may also be absorbed (leaving often small black spots of pigment to mark their existence), and the inflamed nerve itself tends in most cases to become more or less atrophic.

Symptoms.—Rapid failure of sight (both near and distant), with blurring of objects, is frequently complained of in acute neuro-retinitis, but it is most important to remember that severe optic neuritis may exist without any defect of vision whatever. More or less headache, occasionally sickness, pain in the back of the eye. Some tenderness on pressing the eye backwards, sometimes photophobia. Irregular limitation of the field of vision as tested with the perimeter, a similar defect of colour fields (or reversal of their order in cerebral tumour). Imperfect action of the pupils to light, and a failure of vision especially marked towards evening or in a dim illumination. All or some of these symptoms may be present in a case of optic neuritis.

Causes and Forms of Optic Neuritis.—1. Intracranial tumours, gummata of the meninges or brain, abscess, and meningitis (tubercular, traumatic, etc.), are frequent causes of double optic neuritis. This is often pure papillitis, but in some cases the changes in the retina (hæmorrhages and white patches) are just as extensive as in renal retinitis (see No. 3). In the case of neuritis due to tubercular meningitis, tubercular nodules are occasionally developed in the choroid and retina, some way from the disc.

Optic neuritis, slight and transient, is seen in a few cases of severe concussion of the brain; and optic atrophy, probably from rupture of the optic nerve or hæmorrhage into its sheath,

may occur on one or both sides after fracture of the anterior fossa of the skull.

2. Optic neuritis has been noticed in connection with most of the specific fevers, but especially during the secondary stage of syphilis. In the latter case it comes on six to eighteen months after the primary chancre; the retina, and often the vitreous, becomes blurred and hazy, but well-defined white patches of exudation are not often seen.

3. Certain morbid conditions of the blood and vascular system may give rise to neuritis and neuro-retinitis; of these the chief are albuminuria, anæmia and leucocythæmia, gout, diabetes, lead-poisoning, and the high tension of the arteries which goes with hypertrophy of the heart and sometimes chronic nephritis.

In the neuritis from all these causes there is an especial tendency to hæmorrhages into the retina, and when due to kidney disease or to diabetes there are generally many whitish patches of exudation and degeneration in the central part of the retina, often grouped in a radiating manner round the macula. In neuritis due to anæmia there may be extreme swelling of the retina and disc, which quite hides the vessels.

4. Finally, as rarer causes of optic neuritis, may be mentioned inflammation about the cavernous sinus, disease of the sphenoidal air cell, orbital tumours and cellulitis, periosteal nodes of the skull invading the meninges, middle-ear disease, and possibly cerebral hæmorrhage, whilst some cases occur in which no cause can be found.

Treatment of Optic Neuritis.—When due to intracranial tumour or abscess, it is obvious nothing can be done by medicinal treatment unless the disease be syphilitic in origin. If syphilis be suspected and confirmed by a positive Wassermann reaction, vigorous use must be made of the iodides of potassium and sodium with mercury, and of salvarsan equivalents.

Where syphilis is excluded, or where the papillitis increases despite antisyphilitic treatment, trephining should be performed at the earliest possible moment. A prompt decom-

pression operation is often followed by rapid decline of the papillitis, and sight may be saved.

The ophthalmic surgeon will be asked for his opinion upon the character of the papillitis as a help to **localizing** an intracranial tumour; he will need to determine—(1) whether one or both discs are affected; (2) and if both, then which is the one primarily affected. This point will be decided by the apparent age of the papillitis, and not merely by the greater degree of swelling. Opinion is divided as to the localizing significance of papillitis in intracranial tumour; weighty evidence goes to show that the papillitis is '*ipsolateral*'—*i.e.*, greatest on the side of the intracranial lesion—but the rule is not absolute.

For optic neuritis in secondary syphilis mercury should be freely given, or salvarsan (see Treatment of Iritis), stimulants should be forbidden, and the patient must shade the eyes or wear protective goggles, of course refraining from any work with them. The prognosis, if the case be seen early and the treatment be thorough, is very good.

The treatment of neuritis due to renal or vascular disease, or the other causes mentioned in No. 3, is a matter which belongs to general medicine. It may be mentioned here that the discovery of neuro-retinitis in a case of chronic nephritis makes the prognosis bad, most of the cases—at any rate, amongst hospital patients—ending fatally within six to eighteen months after the eye affection has been noticed. The prognosis of neuritis due to anæmia is, on the other hand, favourable as a rule; if proper dieting and hygienic measures are adopted, with administration of iron (and purgatives if required), perfect recovery may result.

Atrophy of the Optic Nerve is diagnosed by the abnormally white hue of the disc, sometimes with shrinking of the arteries, and to a less extent of the veins. If it is a result of inflammation (post-neuritic), there is usually some irregularity and pigmentation of the border of the disc, and fine white lines along the vessels are not infrequently seen. Further, minute changes at the yellow spot exist in a large proportion of the

cases. Sometimes, however, atrophy of the optic nerve is primary, that is, not preceded by neuritis—*e.g.*, tabes and Leber's hereditary atrophy—and then the sharp outline and whiteness of the disc are the only ophthalmoscopic signs.

Gradual failure of sight (especially in the evening), contraction of the field of vision, with more or less colour-blindness especially defect for red and green), are the chief symptoms of optic atrophy or of slowly progressing optic neuritis.

Primary Optic Atrophy in Nerve Diseases.—Of diseases of the brain and spinal cord, the chief is **locomotor ataxia** (tabes dorsalis). The atrophy is nearly always symmetrical. Its symptoms have already been mentioned, but it remains to point out the other symptoms of tabes which are usually present when the atrophy comes under notice. One of the most important is the **condition of the pupils.** They may be abormally contracted (myosis) or unequal, and they will generally be found to contract with convergence of the eyes, but not to respond to light. This peculiar and important sign is known as the 'Argyll-Robertson symptom,' and should always be carefully tested for in any suspected case of tabes. Further, paralysis or paresis of one or more ocular muscles (*e.g.*, the levator palpebræ and one of the recti) is not uncommonly present for a time. The loss of knee-reflexes, the muscular inco-ordination, the darting pains in the limbs, etc., need only be mentioned.

Optic atrophy is also met with in disseminated sclerosis, and with nystagmus may be the only symptoms of nerve disease.

Tabes is now known to be a late manifestation of syphilis. Accordingly so soon as the diagnosis is assured, vigorous treatment with mercury and salvarsan equivalents should be instituted. The prognosis is not good; nevertheless, every possible measure should be exploited.

It is most important to diagnose these cases from what is known as **retrobulbar neuritis** (inflammation of the optic nerve behind the globe), and from toxic effects, of which the chief is :—

Tobacco Amblyopia. — In tobacco-poisoning, the papillo-macular bundle of nerve fibres in the optic nerve is chiefly affected, and except for pallor of this bundle filling the outer quadrant of the disc, the fundus looks quite healthy. The condition was formerly held to be due to a retrobulbar neuritis, but it is probably caused by nicotine-poisoning of the ganglion cells of the retina.

The following are the chief symptoms :

1. Exact or almost exact symmetry of the visual defect—commonly the patient sees only about $\frac{6}{6}$ and 14 J when he comes under care. A few rare cases are recorded in which one eye has failed some time before the other.

2. The field for white is practically normal, but by testing with small pieces of coloured paper there is found to be a scotoma (blind area) for green and red, which involves the fixation-point, and extends outwards more or less beyond the normal 'blind spot' corresponding to the optic disc. Sometimes there is also a scotoma for yellow, and still more rarely for blue ; and in severe cases the patient hardly distinguishes the colour of red and green patches in any part of his field.

3. The patients are almost invariably men who have been addicted to smoking strong dark tobacco (shag, cavendish, or 'returns') for long periods and in large amounts. Generally they own to using $\frac{1}{2}$ ounce of shag daily, though in persons with special susceptibility to tobacco smaller amounts will produce amblyopia. Alcoholism is an undoubted accessory in the production of the condition.

4. If smoking and chewing tobacco be given up, the vision will, as a rule, steadily improve, and in a large proportion of cases is perfectly recovered. Recovery appears to be hastened by giving nux vomica (tinct. nucis vomicæ ℿv, ter die ex aquâ). Since the amblyopia occurs mostly in workmen who cannot always give up tobacco, it is well to provide a substitute. Chewing-gum made up with quassia is effective, and improves the appetite for food ; ginger-root or acidulated drops help in other cases.

The symptoms of tobacco amblyopia have been described

fully, since it is a fairly common disease, and if once diagnosed, a very satisfactory one to treat.

Retinitis Pigmentosa.—In this peculiar disease there is symmetrical progressive failure of sight and narrowing of the visual field; the defect is marked in the dusk, and known as 'night-blindness.' The ophthalmoscopic signs are a wax-like atrophy of the discs with a shrinking of the vessels, and the development of a peripheral ring of coal-black pigment patches in the retina, and often overlying the vessels. These patches are stellate, or spider-like, with processes which join those of neighbouring patches; they have been aptly compared to bone-corpuscle as seen in microscopic sections. The disease comes on in childhood or early adult life. It is often seen in more than one member of the family, and may be associated with deaf-mutism. A history of consanguinity of marriage is obtained in some of the cases. Retinitis pigmentosa tends to progress towards complete blindness, and no treatment is known to be of avail.

It may, however, be mistaken for syphilitic choroido-retinitis, which is greatly benefited by specific treatment; but in these cases there is distinct evidence of old papillitis, and the pigment patches are less regularly arranged and do not show the branching processes.

Retinal Detachment and Hæmorrhage, etc.—A severe blow on the front of a healthy eye may produce either single or multiple extravasations into the retina, choroid, and vitreous. But if the patient be highly myopic, a slight contusion, or merely the strain of stooping, etc., may cause detachment of the retina. This is recognized by the sudden onset of blindness, which may only affect the upper half of the field, since the detachment is nearly always of the lower part of the retina. On ophthalmoscopic examination, the retina is seen to come forwards into the vitreous, its surface being raised into ridges over which the branches of the central vessels can be distinguished. The appearance of the white furrowed surface and the dark retinal vessels that look like bent wire is quite characteristic, especially when taken with the history.

Treatment resolves itself into keeping the patient absolutely quiet in bed in the hope that the retina may return to its bed. Some cases are reported of success following (1) use of subconjunctival injections of saline and cyanide of mercury solutions; (2) operation by puncturing the eye at the site of the lesion, cutting through sclera and retina into the vitreous. Sometimes bands of opacity can be seen in the vitreous; then cure is hopeless.

Care must be taken to determine that the detachment is 'simple,' and not secondary to new growth. This can be done by **transillumination** (see p. 85); rarely detachment is caused by the presence of a parasite—the cysticercus of the *Tænia solium*.

Hæmorrhages into the retina and vitreous sometimes occur spontaneously in young subjects, inherited gout and constipation being held to be the chief factors in their causation. Treatment with laxatives, etc., in such cases is often followed by absorption of the hæmorrhage and recovery of good vision.

Rupture.—A linear streak in retina or choroid is sometimes the result of injury to the eye, rupture due to contrecoup, or stretching of the tunics, and hence generally met with near the centre of the fundus, opposite to the part struck. In other cases a definite 'hole' at the macula may be produced.

Opaque Nerve Fibres.—The nerve fibres of the retina have no medullary sheath; they are therefore quite transparent. In a few cases some of the fibres possess a medullary sheath, and can be seen as a sharp, clearly defined white 'flare,' spreading from the disc. The vessels tend to be buried in the fibres. The cleanness of the whole fundus and media, and the absence of any symptom of disease, will enable such congenital anomalies to be readily distinguished from the blurring of the disc in optic neuritis.

Tumours of the Retina.—The chief tumour met with in connection with the retina is a glioma, or glio-sarcoma. It develops in childhood, and tends not only to grow forward into the vitreous, but to extend backwards along the optic nerve to the brain, or into the orbit. Increase of eye-tensions

a white mass seen with the ophthalmoscope, blindness of the affected eye, and the early age of the patient, are the chief features. The parents may bring the child because the eye shines like a cat's eye; the appearance is due to reflection of light from the white mass. Excision of the globe, with division of the optic nerve far back, is the proper treatment, and may prove curative if done early. Glioma may be simulated by inflammatory degeneration of the retina and vitreous (pseudo-glioma), but the tension is then usually below normal.

Tumours of the Optic Nerve.—Growths behind the globe may be within the dural sheath or involve it. *Intradural growths* are fusiform swellings of neuro-fibromata, and not very malignant; they are liable to myxomatous degeneration from pressure of the sheath. *Extradural growths* are usually fibromata, and may destroy the nerve by pressure.

Symptoms are—Proptosis, loss of mobility of the eye, and resistance to backward pressure, rapid increase of hypermetropia from pressure of the growth on the back of the eye, then gradual loss of sight as optic neuritis and atrophy set in. Excise the growth by an appropriate operation—*e.g.*, Krönlein's—and save the globe if possible.

The Retinal Vessels.—These may be affected by disease, and since they can be seen by the ophthalmoscope, their examination is of the greatest service to the physician.

1. *Pulsation.*—The arteries cannot be seen to pulsate in health; pulsation may be seen in glaucoma and in aortic regurgitation.

2. *Sclerosis.*—With general angio-sclerosis the retinal arteries show marked alteration. They appear to be irregular and beaded; the light reflex from their walls is hard and white; where they cross over veins they tend to obliterate the blood-channel. In extreme cases the arteries may appear as white lines. Rupture of these weak vessels and hæmorrhages may be looked for.

3. *Embolism of the Artery.*—The retinal artery is a terminal branch, and has no anastomosis. If it be plugged by a particle carried in the blood-stream—say a fragment of lymph from an

inflamed valve of the heart -there is sudden and complete blindness. It is usually on one side, and causes no pain. The fundus shows a pale swollen retina, a marked cherry-red spot at the macula, thready arteries, and narrow veins. In a few cases the macula is supplied by a separate cilio-retinal artery; then central vision is preserved.

4. *Thrombosis of the Central Vein* occurs in old people whose arteries and heart are diseased, and occasionally in orbital cellulitis. There is extreme engorgement of the retinal veins and narrowing of the arteries; there are numerous hæmorrhages over the whole affected area. Prognosis is bad; atrophy of the nerve usually follows.

XIX. CATARACT.

It is most important to recognize the different forms of cataract, since they vary greatly in prognosis, some steadily advancing to complete opacity of the lens, others remaining absolutely stationary. Where cataract is suspected the eye should be examined by oblique focal illumination; in cases of partial opacity of the lens the best view of it will be obtained (after dilating the pupil with homatropine) by using a magnifying lens of 12 D to 20 D in the ophthalmoscope and carefully focussing. Examine the fundus where possible; its condition may indicate the cause of the cataract. Never fail to make the four tests given on p. 101.

Senile Changes in the Lens.—In every adult with the advance of age the lens becomes hard, less elastic, and yellow. In such cases cataract may be suspected if the eye be examined by oblique illumination only, but the use of the ophthalmoscope will prove that none exists by the perfect view of the fundus that is obtained.

Nomenclature.—If the opacity commences about the centre of the lens, it is called a *nuclear* cataract; if at the periphery, a *cortical* one. Nuclear cataracts generally occur in old patients (senile form), as do many cortical ones, but a large proportion of the latter develop at middle age. Cataracts are

further classified by their consistency—hard or soft: the *hard* variety is senile, and can only be removed by extraction; the *soft* variety includes infantile and most occurring under the age of thirty years—for these operations involving absorption by means of the aqueous (needling, suction, etc.) are performed.

Senile Cataract is commonly seen after the age of forty-five or fifty. It is due to an irregular shrinkage of the lens either in the cortex or the nucleus, whereby clefts filled with fluid are formed between the fibres. Defective nourishment of the lens is the primary cause, and it has been stated that a considerable number of the patients present atheromatous changes in the carotid vessels, or other evidence of impaired circulation.

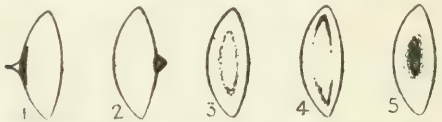


FIG. 47.—Sections of cataractous lenses. The flatter curve to the right hand represents the anterior surface.

1. Congenital post-polar cataract, with persistent hyaloid artery.
2. Anterior polar cataract, caused by perforation of the cornea in ophthalmia neonatorum.
3. Lamellar cataract (rachitic).
4. Cortical cataract (senile shrinkage).
5. Nuclear cataract (senile sclerosis).

Subjective Symptoms.—The first symptom is dimness of vision, especially for distance; sometimes the near vision is at first unusually acute, owing to the lens shrinkage causing slight myopia. The patient may complain of seeing two or more images with the affected eye (monocular diplopia) when the changes are incomplete. The rate of progress is very variable; usually one to three years elapse before the cataract is mature or ripe; nuclear cataract is very slow to mature, but cortical quicker, especially when it occurs in a comparatively young patient (*e.g.*, forty to fifty years old).

The earliest objective symptoms of senile cataract are best detected with a plane retinoscopy mirror. Glistening crack-like marks in the lens come and go as the mirror is moved.

Examined with an ophthalmoscope and a +20 D lens, these marks can often be seen to be caused by minute bubbles or spaces in the lens. Later the marks become denser and recognizable by oblique illumination.

Varieties.—A *Morgagnian cataract* is one in which a very hard nucleus is surrounded by liquid or very soft lens matter; it is nearly always an over-ripe one.

A *black cataract* is very rare. The lens is universally hard, and dark brown in colour; it is less easily detected by direct illumination, and the patient usually retains more vision when it is complete than in the ordinary yellowish-white or white form—*i.e.*, he can count fingers held at the distance of a few

FIG. 48.—Views of cataractous lenses, pupil dilated; the opacities appear dark against the illuminated fundus:

A. Nuclear cataract (senile sclerosis).
B. Cortical cataract (senile shrinkage).
C. Lamellar cataract (rachitic—note the radial markings where the ends of the opaque fibres unite, and the 'riders' (above and to left) indicating a secondary layer of opacity.
D. Congenital dot cataract.

feet. An *atrophic cataract* is due to shrinkage, and sometimes to calcification of a lens which has been opaque for many years; it is most unfavourable for operation. A *green cataract* is a consequence of glaucoma. The lens nucleus is hard and partly opaque; it shines with a greenish hue.

Prognosis of Operation for Senile Cataract.—Taking the statistics of the modern method of extraction, it may be said that usually 5 per cent. (1 in 20) are complete failures, owing to suppuration, severe iritis, etc. A considerable number of the 95 per cent. of successful cases do not attain perfect sight after the operation, owing to persistent irritability of the eye, irregular astigmatism, slight iritis, etc.; and in a few cases

sympathetic inflammation of the other eye follows an apparently successful extraction. As a general rule, a senile cataract should not be extracted until it is ripe, for the risks of the operation are greater and the prospects poorer in operation on unripe cataracts. Only one eye should be operated on at a time, and operations should be avoided, if possible, in very old and feeble patients, and during extremely hot or cold weather. It is most important to remember that the existence of a muco-purulent discharge (generally from chronic inflammation of the lachrymal sac) will almost certainly lead to suppuration after cataract

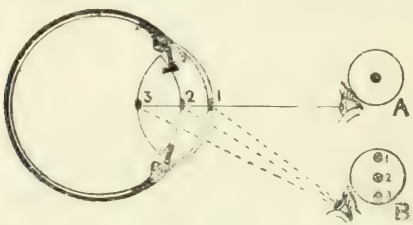


FIG. 49.—**The Parallax.**—To determine the position of opacities of the media. Looking straight forward into the eye, the observer sees only one spot in the centre of the pupil, as at A. Looking from the side, three spots are seen, as at B. Notice the distant spot appears to move to the side of the observer, the near spot away from him, and the spot level with the iris remains central. The student should notice the parallax to be seen from the window of a railway carriage: the near telegraph-posts flash past, but the distant objects appear to travel with the train.

extraction, and hence the operation should never be undertaken until the inflammation is cured by appropriate treatment.

When is a Case of Senile Cataract ready for Operation?—As a rule, when one eye fails before the other, and so long as the patient sees well enough to do his work with the better eye, it is wise to defer operating on the other; for, apart from the slight risk of sympathetic ophthalmia following the operation, and supposing that all goes well, the operated eye will of course require a strong convex glass, and the image formed on its retina will be of a different size to that formed in the other eye,

and hence binocular vision cannot be well carried out. Supposing the cataracts to be so advanced that the patient can no longer see to do his work—in fact, is practically blind—the following tests should be tried before deciding upon operation :

1. Examine by focal illumination. If the opacity comes forward to the iris, so that the latter throws no shadow on the lens, then the cataract is probably mature (Fig. 50).

2. Throw a strong light suddenly on the eye, the other being covered ; the pupil should contract to the illumination.

3. The patient should have distinct perception of light—*i.e.*, he should know whether the eye is shaded or not.

4. He should have 'good projection' or fair peripheral vision —*i.e.*, in a dark room, when looking straight forwards, he

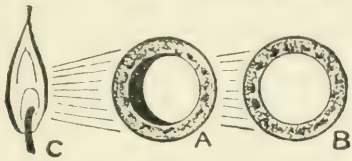


FIG. 50.—The test for maturity of cataract :

C. Candle.

A. An eye in which the opacity is separated from the iris by a layer of healthy lens fibres, so a deep shadow is cast by the iris.

B. The opacity is complete up to the capsule of the lens, so no shadow is cast—the lens is mature.

should be able to tell the position of a lighted candle when moved about in different positions at the distance of several feet from his eye.

Operations on Unripe Senile Cataract (p. 207).—The discomfort caused to patients by the bad vision of unripe cataracts has led to many attempts at amelioration.

1. Preliminary iridectomy and massage of the lens through the cornea, Förster's operation. It was occasionally successful.

2. Intracapsular irrigation was devised by McKeown as a step in the regular operation for extraction. It is undoubtedly effective in freeing the lens capsule from the sticky cortical layers of healthy lens fibres.

3. Extraction of the lens in its capsule as recommended by

Smith of Jellundar. When successful, the result is perfect; the risk is loss of vitreous from excessive pressure.

Unilateral Cataract.—When a cataract is found in one eye only, and the other eye is quite healthy, some cause acting upon the single eye should be sought for, such as congenital defect and persistent hyaloid artery, injury, old detached retina, or irido-cyclitis. A bad projection will negative any idea of operation.

Diabetic Cataract.—This form of cataract is very like the cortical senile form. It is always bilateral. It usually matures very rapidly, particularly when the diabetes is of a severe order. As regards treatment, everything depends on the patient's state of health; if he has lost much flesh, is affected with lung disease, or if the quantity of sugar in the urine be very large, no operation should be undertaken.

Traumatic Cataract.—If the lens capsule is wounded by a penetrating instrument, as a rule the whole lens becomes opaque within a few days, owing to the soaking in of the aqueous humour. The lens matter swells and protrudes more or less into the anterior chamber. Iritis is very liable to occur, and the pupil should therefore be kept dilated with atropine. Should, however, the tension rise and the eye become painful, owing to the rapid swelling of the lens, it is best to make a corneal section with a narrow keratome (usually on the outer side of the eye); introduce a curette just within the wound, and let out as much of the white matter as will come. Atropine should be used three or four times a day until all trace of iritis has subsided, whether any operation be performed or not. If the cataract is gradually absorbed by the action of the aqueous, the pupil will nearly always remain blocked by the remains of opaque capsule and lens matter; but provided the patient can see well with the other eye, it is best to leave this alone, since an operation on such an eye is by no means free from risk of causing (1) inflammatory or suppurative changes in the eye itself, and (2) sympathetic mischief in the other one.

Concussion Cataract is a form of traumatic cataract in which the opacity of the lens (generally extremely limited, and in the

form of dotted opacity on the anterior or posterior pole) is due to a blow on the eye (*e.g.*, with the fist), without a penetrating wound of the cornea. It is probable that in most of these cases the capsule is very slightly ruptured. Of course, being usually opposite the centre of the pupil, these small opacities may considerably interfere with vision; but the rest of the lens may remain quite clear, and no treatment is then indicated. In other cases the opacity slowly invades the rest of the lens; an operation may then be called for, owing to the cataract interfering with the patient's work, etc., and will consist either in needling in young subjects or extraction in old ones.

Lamellar Cataract (syn., Zonular Cataract).—The nucleus and cortex of the lens are clear, but between them intervenes a layer (lamella) of opaque matter, with, in most cases, little spicules projecting into the clear peripheral part. This peculiar form of cataract is either congenital or comes on soon after birth; affects both eyes; and does not tend to spread to the whole lens. Its subjects have, in many cases, had convulsions in infancy, and present peculiar malformations of the permanent teeth ('honeycombed'). These (especially the incisors and the canines) are more or less dwarfed or grooved horizontally. This horizontal wearing away of the enamel is thought to be due to damage of the enamel organ by the fits (Horner); or to the mercury which has been given for the convulsions (Hutchinson). The amount of visual defect in a patient with lamellar cataract varies much; as a rule, it is only noticed when the child begins to learn to read. Occasionally its subjects are mentally defective. To see the cataract properly the pupil must be dilated, when the white circle with the little projections of opacity are seen by focal illumination, or by using the ophthalmoscope (Fig. 48, C). The patient sees better when the pupil is dilated, since then the rays can pass through the clear part of the cortex, and in attempting to read, etc., he holds the object near to the eye, in order to compensate by the increased size of the image for its want of clearness.

Treatment.—If the vision is sufficiently good to enable the patient to read moderately well (*e.g.*, $\frac{6}{18}$ and 4 J), no operation

should be performed; but in other cases the opaque lens will need to be removed by operation (p. 200).

The following are forms of cataract which are more or less unsuited for operation, or in which a perfect result cannot be expected (see Figs. 47 and 48):

Secondary Cataract.—After iritis, glaucoma, etc. In highly myopic patients with cataract the vitreous is often abnormally fluid, and there may be detachment of the retina, or other degenerative changes.

Congenital Post-polar Cataract.—A plaque of dense opacity on the back of the lens, usually associated with persistent hyaloid artery. It should be left alone.

Discoid Cataract.—A small disc of opacity situated in the posterior lamellæ of the lens. It usually affects vision very little. It is markedly hereditary, and is sometimes termed 'Coppock,' after the first family investigated.

Coralliform Cataract.—A mass of tubular opacities occupying the centre and fore-part of the lens. It disturbs vision seriously. It is frequently hereditary.

Congenital Dot Cataract.—Numerous small, oval, clearly-defined dots studding the periphery of the lens, sometimes of bluish tint; they affect vision little or not at all.

Anterior Polar (Pyramidal) Cataract.—The opacity is very small, and, as a rule, remains stationary, and requires no treatment. This cataract is often the sequence of an attack of ophthalmia neonatorum.

Hereditary Cataract.—Many forms of cataract have a strongly hereditary tendency. Numerous pedigrees have been published tracing the existence of some peculiar form of cataract through many generations (see 'Treasury of Human Inheritance,' 1910, Part IV., sect. xiii *a*).

Dislocation of the Lens—1. *Partial Dislocation* (subluxation).—(*a*) Congenital, usually bilateral; due to lack of development of the lens ligament. The lens is usually drawn up and out behind the iris. (*b*) Traumatic, from blows rupturing the lens ligament. The iris is tremulous; across the dilated pupil will be seen the crescentic edge of the displaced lens; the lens

may become opaque. The refraction of the eye through the lens is highly myopic; clear of the lens, hypermetropic. Occasionally the clear part of the pupil is sufficiently large for use, and with cataract glasses vision is good. If the lens prevents vision it should be removed.

2. *Complete Dislocation* (luxation).—In old-standing disease from myopia, or from injury, the lens may be loosened and pass into the anterior or posterior chambers.

Treatment.—If there be vision in the eye spike the lens by driving a needle through the sclera; then proceed to incise the cornea and remove with forceps or scoop. If the eye be blind excise it.

Couching.—An old operation for cataract by dislocating the lens into the posterior chamber. The native Indian doctors still do this. Most eyes are lost by cyclitis or glaucoma.

XX. INJURIES TO THE EYE.

With the various forms of injury to the eye and their treatment the student should be thoroughly familiar, as they are very often met with in practice.

Employers' Liability Acts.—Owing to the frequency with which cases of injury are the subject of arbitration or lawsuits for compensation, it is of the utmost importance that a surgeon should carefully record in writing his observations of a case at each time of seeing it. The first examination should include a systematic examination of each eye after the manner suggested in the introductory chapter, and at this time he should record the vision of *each* eye, injured and uninjured. When a man is injured his first desire is to know that his sight will be saved, and his answers are likely to be his best; later, prospects of indemnification may bias his replies.

For the method of testing the vision in such cases, see p. 163.

We may consider injuries under the following heads:

Burns and Scalds.—In recent cases of burns or scalds of the lids it should be ascertained as soon as practicable whether the globe has escaped injury or not. Some non-irritating oint-

ment should be applied between the lids from day to day, and if there be much discharge douching with boracic lotion is advisable. If there is much swelling of the lids, continuous cold applications give relief, and may save the eye. If, however, the cornea has been severely injured, and subsequently sloughs, enucleation may become necessary.

Burns of the conjunctiva, especially if due to caustic lime or strong acids, are almost certain to be followed by adhesion between ocular and palpebral layers (symblepharon), which in a few cases may be subsequently relieved by operation. But the great risk of such injuries is to the cornea, which is seen to be whitened and dim when the lids are separated. The opacity rarely clears; indeed, it generally becomes worse, and a most guarded prognosis should be given. In cases such as these it is a safe rule to instil oil directly they are seen. Any heavy neutral oil, such as olive oil, cod-liver oil, or castor oil, will do. To wash a lime burn with water is only to add to the burning power of the lime. Oil relieves the pain. Pure cocaine will dissolve in castor oil, and may be used. We can then open the lids and pick out any particle to be seen. These cases will need careful attention during the healing stages, to prevent, so far as possible, adhesions between conjunctiva of lids and globe, by daily passing a glass probe into the fornices. The eye should be lightly bandaged.

Foreign Bodies.—Small sharp objects often become firmly fixed in the cornea, and if not readily seen by daylight should be searched for with the aid of a lens or binocular magnifiers (p. 4) and artificial illumination. Apply a 2 per cent. solution of cocaine until the conjunctiva is insensitive, and then, standing behind the patient, remove the foreign body with a small spud, or if firmly embedded with a mounted needle (Figs. 51 and 91). The removal is rendered easier by gently fixing the globe with the left index-finger, pressing through the lower lid. If a piece of steel or iron has been fixed for some time, a ring of rust will remain after it has been extracted; this need not be removed. Bandage the eye for twenty-four hours, and if the irritation is severe use atropine and hot fomentations.

If 'something has gone into the eye,' and it is not found on the cornea or ocular conjunctiva, look for it in each palpebral fold, everting the upper lid, and making the patient look downwards, in order to expose the upper fold. It is very often found in the shallow groove on the inner surface of the upper tarsus. Sometimes a foreign body of considerable size (*e.g.*, an insect or oat-grain) has travelled under the upper lid and set

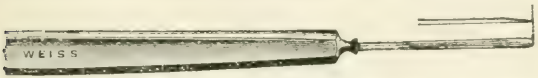


FIG. 51.—Spud for removing foreign bodies from cornea. The blade is shown flat and in profile.

FIG. 52.—Harman's spud for removing surface foreign bodies. The end (shaped like a golf niblick) is pressed vertically on the cornea beside the foreign body, thereon a foreward movement lifts the object without disturbing the epithelium.

up conjunctivitis without the patient being aware of the cause of his trouble; the conjunctivitis will be of one eye only, and this should excite the surgeon's suspicion as to its cause.

Occasionally an eyelash becomes fixed in one of the puncta lacrimalia, and sets up much irritation; in these cases the congestion, being greatest on the inner side of the globe, will attract attention. The offending lash should be removed.

In summer the wing cases of small beetles may cause trouble; one may become affixed to the cornea, and set up a lesion not unlike a phlyctenule. Examination with the loupe will determine its character.

A foreign body, especially a chip of iron or steel, is sometimes driven almost through the cornea, so that one end projects into the anterior chamber: it is then impossible to remove it

by the ordinary way, and a broad needle must be entered towards the margin of the cornea, and its end used to press up the foreign body, whilst the wound is enlarged and the foreign body extracted; this operation requires much care, and it is best to give an anæsthetic before it is attempted. The foreign body may be driven right through the cornea, so as to rest in the anterior chamber, or to be fixed in the iris or lens; to remove it make a small corneal section, and seize the fragment with fine iris-forceps. If the foreign body be iron, it may be removed by the fine point of an electro-magnet introduced through a corneal wound, or with the help of Haab's giant magnet. Some of the modern hard steels are non-magnetic; inquiry should be made as to the source of the fragment. If the lens capsule has been wounded cataract will certainly follow; for its treatment, see Traumatic Cataract (p. 102). If the foreign body be fixed in the iris, a small piece of the latter may be excised, bringing with it the fragment.

It should be remembered that the patient is often quite mistaken about the size of the foreign body, and that the wound of entrance is often difficult to find. If there is any doubt as to penetration by a foreign body, and it cannot be seen on examination, homatropine should be used, and the fundus thoroughly explored.

Siderosis.—When a piece of iron or steel remains embedded in the eye it becomes firmly encased in fibrous tissue. Chemical action set up by the presence of the metal causes changes in the eye, vitreous degeneration and opacities, gross pigmentation of the choroid, and optic atrophy. If iritis should supervene or the eye be blind, it should be excised without delay for fear of sympathetic disease.

Localization by X-ray Photography is of great service. Narrow metal bands are strapped on to the lids and temple; skiagraphs of the head are taken from front and side. If a dense foreign body be present, its shadow can be seen and its position determined by its relation to the shadows of the metal bands.

The position of the fragment will determine its treatment.

Fragments of iron have often been removed from the posterior part of the eye by means of an electro magnet point introduced through a wound in the sclera, and sometimes with complete success; but unfortunately in most cases inflammation supervenes, and vision is much diminished.

Suppuration may follow penetrating wounds of the cornea or sclera, especially if some septic or dirty matter is introduced, and there is hardly any limit to the variety of foreign bodies which are occasionally embedded in the eye. Bits of glass (from bursting of bottles) and shot are common ones. Air-bubbles are occasionally seen in the vitreous after a wound of the sclera, and are somewhat difficult to distinguish by sight from fragments of iron, etc.

If, in spite of treatment, the eye inflames severely, so that sight is lost, and especially if a foreign body is believed to be still in the globe, excision should be performed.

Abrasions of the Cornea.—Minute scratches of the corneal epithelium may give rise to intense photophobia and lachrymation, they are sometimes seen in women nursing infants, and due to the latter's fingers. Hypopyon ulcer and iritis may be set up, and in elderly people many cases of serpiginous ulceration (see p. 53) are started by an abrasion of the cornea.

Continuous warm fomentations form the appropriate treatment until the abrasion is repaired. If the injury be large and there be irritation, insert atropine ointment between the lids; the drug quiets the ciliary muscle and iris, and the fatty base is soothing to the cornea. Recent comparative investigation of the rate of healing of corneal injuries under the influence of heat, cold, perchloride of mercury, cocaine, and dionine, have proved conclusively that heat favours healing, whilst the others are either indifferent or actually retard it.

Contusion or Concussion Injuries.—As is well known, in most cases of 'black-eye' the globe itself escapes injury. The best method of procuring rapid absorption of early ecchymosis is to apply a cold pack (or an evaporating spirit lotion) over the closed lids, and after twenty-four hours or less to use warm fomentations. With extensive ecchymosis of the ocular con-

junctiva, the iris may be for a time discoloured or stained in part; or traumatic mydriasis may be present for a few days. In this condition the pupil is dilated, and does not act on stimulation, or only very slightly, and the power of accommodation may be lost. Vision may at the same time be impaired from concussion of the retina without perceptible injury, perfect recovery ultimately ensuing. But more serious damage may be done by a blow on the front of the globe, the following lesions resulting in some cases:

1. Rupture of the eye with, frequently, escape of the lens and some of the vitreous, either under the conjunctiva or through the wound. The rupture is nearly always at the thinnest part of the sclerotic—that is, just behind the cornea,

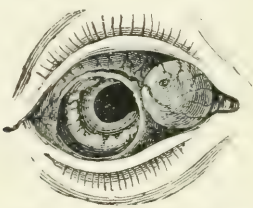


FIG. 53.—Rupture of globe, with dislocation of lens inwards beneath conjunctiva.

and often involves the latter. The tension of the globe is lost; excision is the only treatment.

2. Dislocation of the lens, partial or complete. This should always be suspected if the iris remains tremulous on rapid movements of the eye, or if one part is pushed forward and another depressed. Secondary glaucoma is very likely to follow if the dislocation be complete or nearly so.

3. Hæmorrhage into the (1) anterior chamber, (2) vitreous, or (3) retina. Blood in the anterior chamber (hyphæma) is absorbed in a few weeks. In the vitreous, blood can be detected as dark floating masses with the ophthalmoscope; it may be largely absorbed, but vision is nearly always much impaired.

Retinal hæmorrhages absorb, but may leave permanent scotomata—*e.g.*, 'hole in the macula' (p. 95).

4. Rupture of the retina or choroid at the posterior pole of the eye, by contrecoup.

5. Opacity of the lens, partial or complete. See Concussion Cataract (p. 102).

6. Dark pigmentary changes in the retina, with more or less atrophy of the optic nerve, may come on after a blow on the eye; they also are most marked in the central region.

7 Detachment of part of the iris from its ciliary origin, iridodialysis (Fig. 42, 1).

There is no reason to advise excision after injury followed by the conditions 3 to 7, since some useful vision may be retained, and there is no risk of sympathetic disease.

Penetrating Wounds of the Eye.—Cleanly-cut wounds of the cornea unite rapidly, but with some impairment of vision in most cases. Wounds of the sclerotic and conjunctiva may be sutured with very fine silk, after cleansing with a mild antiseptic lotion. It is, however, unnecessary to sew up small wounds; they unite well if gentle pressure be maintained on the eye by means of pad and bandage. Wounds of the sclerotic within a quarter of an inch immediately behind the corneal margin may involve the ciliary body and cause cyclitis, especially if the ciliary body be prolapsed or incarcerated in the wound. Inflammatory changes following such wounds are extremely liable to be followed by sympathetic disease. Hence, if after such injuries sight is completely or almost completely lost (*e.g.*, if only perception of light is retained), there can be no question that immediate excision should be performed. If, however, a wound of the ciliary region be not followed by much impairment of vision, the question of treatment becomes very difficult. Excision should be advised, even if the wound of the ciliary region be small, if severe iritis follow; and excision should be urged if the lens be injured, or if it be probable that a foreign body is embedded in this region.

In the case of recent wounds of the cornea, with prolapse of

the iris, an attempt should be made to push it back with a small spatula. If this fail, the iris should be slightly drawn out and cut off. Eserine should be used if the wound be peripheral, atropine if it be central ; if iritis supervene, use atropine and fomentations.

It will have been seen that the danger of an injury to the eye is not always confined to the eye itself, but that, within an almost unlimited period (very rarely before three or four weeks have elapsed from the date of injury), the other eye may become affected. We have to consider : (1) Sympathetic irritation ; and (2) sympathetic inflammation. Either of these two is especially likely to follow a penetrating wound of the dangerous or ciliary region, but in rare cases they have developed after perforating ulcer with iritis or cyclitis, or even with an intra-ocular tumour. They may occur at any time ; the usual interval is between six weeks and six months after the injury.

Sympathetic Irritation.—Attacks of congestion and watering of the eye, failure of accommodation (shown by sudden dimness of the print), neuralgia of the globe or head, disturbance of vision, floating bodies seen before the eyes, and irritability on exposure to moderate light, are the chief symptoms. These may recur repeatedly, and they do not necessarily indicate threatening sympathetic inflammation. If the exciting eye be excised, the symptoms do not, as a rule, recur. Hence, if the injured eye be still more or less inflamed, painful, and the vision bad, excision should be advised. For though sympathetic irritation does not apparently often pass on to sympathetic inflammation, we can never tell in which case it may happen to do so.

Sympathetic Inflammation.—This terrible disease is essentially a fibrinous irido-cyclitis. Tough adhesions are formed to the lens, which becomes opaque, whilst the vitreous and retina become secondarily involved.

Pathology.—The method of transmission from the exciting eye to the sympathizing one is still doubtful ; the chief theories put forward to explain it are :

1. Germ-transmission through the circulation.

2. Lymphangitis travelling from one eye to the other, especially along the optic-nerve sheath.

3. Spreading neuritis by way of the ciliary nerves.

Free cellular exudation into the ciliary body, iris, choroid, and sometimes into the anterior chamber (serous iritis, see p. 68), is the chief feature in the pathology of sympathetic ophthalmia. The appearance of keratitis punctata (Fig. 41, A) in the uninjured eye is frequently the first objective sign of an attack. Optic neuritis is present in many cases. The disease sometimes is recovered from with fair retention of vision ; the cases of sympathetic serous iritis are the mildest, and occasionally leave hardly any defect of sight. But the prognosis of most cases of sympathetic inflammation is extremely bad ; the pupil becomes occluded by tough lymph, the iris universally adherent, the lens cataractous, and vision may be completely lost in the course of a few weeks or months.

Treatment.—Complete rest of the eyes in a dark room, mercurial inunction, extract of belladonna given internally, counter-irritation to the temple, atropine frequently applied to the eye. Or mercury may be given by the mouth, with belladonna and quinine, but the effect of internal treatment is rather doubtful. It is, of course, essential to use atropine if the case is seen fairly early ; after tough adhesions have been formed it is quite useless.

It might be thought that the exciting eye should at once be excised, but, unless it is absolutely blind, it is perhaps wiser not to remove it, as ultimately it may retain the better vision of the two. No operation should be done on the sympathizing eye until the inflammation has quieted down, and then a free iridectomy (with extraction of the lens, if that is opaque) may do good, though it is to be feared that the aperture formed will become closed again by lymph. Operative interference should, of course, be avoided if any useful sight is retained.

XXI. REFRACTION.

Lenses.—Pieces of glass shaped so as to concentrate, disperse, or bend light passing through them.

Three classes are in common use:

1. *Spherical.*—The surface is regularly curved, like a slice from a globe.

2. *Cylindrical.*—The surface is curved in one direction only. A garden roller is a cylinder; a slice cut off from end to end would be like a cylindrical lens. The *axis* of the lens is not curved; it is at right angles to the curved surface, just as the axle of the garden roller is to its curvature.

3. *Prisms* are wedges of glass. These do not concentrate light. A ray passing through a prism is bent in one direction only, like a green-stick fracture.

Varieties of Lenses.—Lenses are known as: (*a*) *convex*, when dome-shaped; (*b*) *concave*, when cupped; (*c*) *bi*-prefixed, when both sides are alike; (*d*) *plano*-prefixed, when one side is flat; (*e*) *periscopic*, when concave on the side next the eye, convex on the other; (*f*) *simple*, when spherical only; (*g*) *compound*, when spherical one side and cylindrical the other.

Lens Values.—Lenses differ in strength. The flatter the curve the weaker the lens; the sharper the curve the stronger the lens. A lens is measured by its power of focussing light—*e.g.*, a convex lens that will concentrate the sun's rays to a burning spot distant 1 inch from the lens is said to be of 1-inch focus. In practice it is inconvenient to speak of 'focal lengths,' so by agreement a lens having a focal length of **1 metre** is spoken of as a lens of **1 dioptre**; of ½ metre, 2 dioptres; of ¼ metre, 4 dioptres, and so on.

Cylinder Axes.—In placing a cylinder before an eye the position of the axis has to be considered. The position is referred to and marked on a circle graduated in degrees; unfortunately there is no general agreement as to the order of graduation. The student will do well to associate the familiar clock face with the degrees of a circle—*e.g.*, the line from IX to

III is horizontal or 0°, VIII to II slopes 30° from the horizontal, VII to I slopes 60°, VI to XII is vertical, or 90°.

To Find the Value of a Lens.—Hold it up 6 inches from the eye, look through it at a distant object, move it slowly to one side; if the object moves *with* the lens the lens is *concave*; if the object moves *against* the lens the lens is *convex*.

Now match the lens against those in the trial case of opposite sign until two lenses act as a plane lens—*i.e.*, cause no movement of the distant object. The lens is of the opposite sign but of the same value as that taken from the trial case.

To Find the Axis of a Cylinder.—Hold the lens up as before; look through it at some vertical line, say the blind cord, turn the lens slowly round until the cord is vertical, the axis of the cylinder is in that line or at right angles to it. Test the spherical value of each direction separately.

The Optical Combination of the Eye.—The eye has been happily likened to a camera. The optical combination of the eye—cornea, aqueous, lens, and vitreous—focusses light rays upon the retina. A normal eye (emmetropic) is so shaped that parallel rays, in practice those coming from farther than 6 metres, are brought to a focus at the macula. When objects are nearer than 6 metres, the light rays are divergent; to meet this divergence the eye accommodates, the lens ligament is loosened by the ciliary muscle drawing forward the attachment of its fibres, so that the lens becomes more spherical and bulges forward into the aqueous.

Considering the effect on rays passing into the eye, the cornea and aqueous act as a lens of 33 D. The crystalline lens supplements this, and acts as a lens of 22 D when behind the cornea. Since the lens is some distance behind the cornea its effect is lessened, and cornea, aqueous, and lens equal about 50 D. When the eye accommodates, this value is increased, and can be measured.

Measurement of Accommodation.—A coarse hair stretched across a large hole in a piece of card should be held before one eye; the nearest point at which it can be seen clearly is the near-point. Measure the distance from the eye.

Power of Accommodation (Amplitude).—This is great in the young, feeble or absent in the old. The lens is developed from the surface epiblast, and, like the epidermis, is always growing. In adult age it gets so hard and stiff the muscles can no longer alter its shape sufficiently for good near vision. On the average a normal eye has the following accommodation:

Age.	Value in Dioptres.	Near-point.
10	14	7 centimetres.
20	10	10 ,,
30	7	14 ,,
40	5	20 ,,
45	3	33 ,,
50	2	50 ,,
60	1	100 ,,

Presbyopia.—It follows from this table that a man of forty-five years can no longer see to read ordinary type at a comfortable distance. We must supply him with a plus lens to make up for the loss of accommodation.

In emmetropic eyes it is found that on the average a lens of +1 D at forty-five years, 2 D at fifty, 3 D at fifty-five, and 4 D at sixty gives sufficient assistance for near vision. After sixty more than 4 D is rarely required (pp. 128).

Emmetropia.—A term derived from the shout of applause when a Greek chariot took the goal post as closely as possible —*i.e.*, 'well turned.' An emmetropic eye is perfectly focussed for distance. Symbol, E.

A very large proportion of eyes vary in some degree from the normal; the divergence is known as an error of refraction. The various kinds of errors are known as:

Ametropia.—The eyes are not of normal shape; parallel rays are not focussed at the macula.

Hypermetropia (Far-Sightedness).—The eyeball is too short, parallel rays would focus behind the retina. Symbols: H; Hm. = H. manifest, or the degree of H. found by trial with + lens; Hl. = H. latent, or the additional H. found after use of cycloplegic (p. 130).

Myopia (Near-sightedness).—The eyeball has stretched—it is too long; parallel rays meet in front of the retina. Symbol, My.

Astigmatism (lit., 'that which has no point').—Symbol, As., preceded by H. or My., as the case needs. When the curvature of the refracting surfaces of the eye (cornea and lens) is not equal in every direction, the rays do not come to a focus at any one point. The image is distorted.

Varieties of astigmatism:

Simple.—One meridian is emmetropic, the other hypermetropic or myopic.

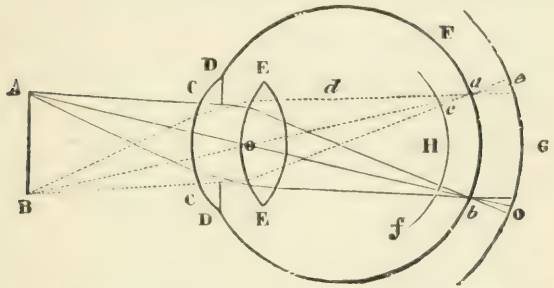


FIG. 54.—H, Hypermetropia; F, emmetropia; G, myopia.

Diagram to represent the condition of an eye when looking at a distant object (A, B), the ciliary muscles being at rest. A clear image is then only formed in the emmetropic eye (F), but by using the accommodation it can also be obtained in the hypermetropic eye (H). G represents the back of the globe of a myopic eye, the image of the distant object formed there being blurred.

Compound.—Both meridians are hypermetropic or myopic, but in unequal degree.

Mixed.—One meridian is myopic, the other hypermetropic.

Regular.—Commonly the cornea is more sharply curved vertically than horizontally; this is corrected by + Cyl. Ax. vertical, or − Cyl. Ax. horizontal, or axes nearly these.

Irregular.—When axes are more or less the reverse of the foregoing *i.e.*, 'against the rule.'

Anisometropia.—The two eyes are of unequal refraction.

Diagnosis of Errors of Refraction.—For the discovery of these errors two methods are available.

1. The objective, in which we examine the eye as an optical instrument with the ophthalmoscope or by retinoscopy.

2. The subjective, in which we find out empirically what glass the patient sees best with. It is tedious and uncertain with even intelligent patients, and impossible with children or illiterates.

Begin by registering the distant vision of each eye separately with a Snellen's test-type, and in adults the near vision also with Jaeger's reading-types; then proceed by the objective and subjective methods of examination.

XXII. OBJECTIVE DETERMINATION OF REFRACTION.

Ophthalmoscopy.—This method had much vogue before the discovery of retinoscopy. It still has certain uses, and should be practised as a means of securing skill in measuring the height of the optic papilla (see Optic Neuritis). Let the patient look into the distance; examine the fundus by the direct method; get as close to the patient—eye to eye—as possible, and the highest plus lens or lowest minus lens with which the fundus details can be seen gives roughly the error of the eye. Astigmatism may be measured by focussing vessels running in different directions. The results are valueless if the surgeon accommodates; and any error of refraction in his own eye must be allowed for.

Theory of Retinoscopy.*—This is a most perfect mode of examining the refraction—in fact, it is the only certain mode, for no help is required of the patient, and the surgeon's vision does not affect the result so long as he can see accurately.

The normal eye has been likened to a photographic camera. Retinoscopy is turning the eye into a magic lantern; we put a light into the eye by the flash of a mirror, and watch the rays as they come out from the eye.

* In this account of retinoscopy *the light* will be taken as the part of the reflex to be watched, and not the shadow, as is commonly taught. Light is something real, something to be seen, whilst shadow is a negation; so to watch the light is the more correct method. Further, I have found students realize better what they are about, and more speedily obtain good results when taught by this method.

Experiments.—Let the student take a small box; cut a hole in the top for a vent, and another in one side in which to fix a convex lens—say 20 D. Fix a candle inside the box; arrange it so that it can be pushed to and from the lens, and so that the flame is on a level with the lens; darken the room.

1. Put the candle at the focus of the lens, 5 centimetres; make the rays coming out of the box through the lens visible by blowing smoke across them; the rays will be seen to be parallel. This is the likeness of an *emmetropic eye.*

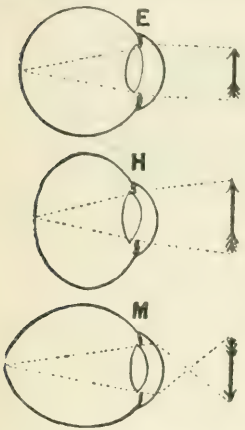


FIG. 55.—The path of the light rays reflected from the fundus of the eye.

E. In emmetropia the rays issue parallel.

H. In hypermetropia the rays issue divergent.

M. In myopia the rays issue converging and cross at a distance from the eye which is short in proportion to the degree of myopia.

2. Push the candle nearer to the lens; the rays will be seen to diverge or spread out. This is the *hypermetropic eye.*

3. Push the candle farther away from the lens, beyond 5 centimetres. The rays will be seen to converge as they issue from the lens, then cross, and so diverge and disperse. This is the *myopic eye.*

If in these three experiments the student gets into the line of light and looks at the candle, in positions 1 and 2 the candle will be seen enlarged and the right way up; in posi-

tion 3 the candle will be upside down, because the rays have crossed. This is practically what happens in retinoscopy: we watch the rays coming out of the eye, and by a slight movement of the mirror we can see whether these rays are parallel, or divergent, or crossed.

Practice of Retinoscopy.—The apparatus necessary is very simple. A room that can be darkened; a good light (electric is very convenient, but the white light of an incandescent gas-mantle is not to be beaten), conveniently placed about 1 foot above the patient's head; **a plane** mirror—a piece of thin

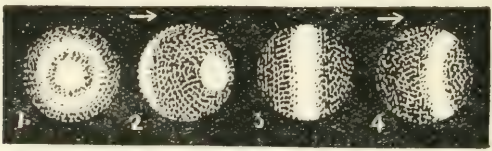


FIG. 56.—Diagrams of light reflexes in retinoscopy with a plane mirror, pupils fully dilated.

1. Hypermetropia of low degree. The central light is the reflex to be considered. The outer ring of light is the effect of the spherical aberration of the lens, and is to be neglected.
2. The same after the mirror has been moved to the right. The central reflex is positive; it has moved with the mirror. The outer ring is negative, and has moved against the mirror.
3. Hypermetropic astigmatism showing a vertical axis.
4. The same when mirror has been moved to the right.

mirror glass, of 1½ inches diameter, with the silvering scratched off the centre part for ¼ inch diameter, mounted on a handle, is sufficient; and a box of trial lenses.

Dilate the patient's pupils (see p. 124), let him be comfortably seated, put on him a trial frame, and cover one eye. The worker sits at a convenient distance—say 1 metre; he holds the mirror to his own eye, looks through the hole, and directs the mirror so that the light of the lamp is reflected into the patient's eye. The pupil immediately turns red, because the light entering the eye is reflected from the red fundus.

Once the student has got the light reflex, let him extend the

lantern simile and suppose the eye to be a signal lantern. He will signal by moving his mirror, and watch for the answer in the movement of the light shining out of the eye. The signal reply will be one of two, either—

1. **Positive**: the light from the eye will move in the same direction as the mirror

2. **Negative**: the light will move in the opposite direction to the mirror movement.

These signals vary as the direction of the rays coming out of the eye varies. If the rays are parallel or divergent, the movement is positive—*i.e.*, the eye is emmetropic or hypermetropic; if the rays are crossed, the movement is negative—*i.e.*, the eye is myopic. (Compare with Experiments 1, 2, and 3.)

Retinoscopy with Lenses.—It follows from this that the quality of the light reflex, positive or negative, can be altered by putting lenses in front of the patient's eye; or, to put it otherwise, we can judge the refraction of the eye by the lens required to neutralize the movement of the light reflex. From the preceding paragraphs we learn that—

A positive light reflex requires a **plus lens.**
A negative light reflex requires a **minus lens.**

Example 1.—The reflex is positive; we put up a plus lens because there is hypermetropia at the distance at which we examine the eye. Starting with a weak lens, we increase the strength of the lens until the positive reflex, coming through the centre of the cornea, is on the point of disappearing. This lens (say, +4 D) shows the error of refraction of the eye for the distance we are working at—1 metre.

Example 2.—The reflex is negative. We put up a minus lens because there is myopia, and increase the strength of the lens until there appears just the least positive reflex coming through the centre of the cornea. This lens (say, −4 D) shows the refraction of the eye at the distance of 1 metre.

The Error of the Working Distance.—We have supposed the work to be done at 1 metre, the distance between patient and surgeon. Consequently we get the refraction of the eye

for this distance; we must correct it for 6 metres, the distance counted as infinity.

A lens of 6 metres focus is negligible, but one of 1 metre focus is 1 dioptre, so our findings are in error by 1 D; the true result will be obtained by the algebraical sum of −1 with whatever is found by retinoscopy. In the preceding examples (+4 −1) = +3 D, and (−4 −1) = −5 D.

Notes.—1. It is essential the patient should fix his gaze on or near the mirror; the bridge of the student's nose is a good place.

2. A comfortable position for the worker is essential. Press the mirror against the root of the nose to steady it; put the left fist under the right elbow to steady the arm. At first the student will have difficulty in finding the mirror reflex · a sheet of white paper pinned on the patient's breast will help.

3. An error of refraction in the worker's own eye does not vitiate the result so long as his sight is good enough to *accurately watch the reflex*.

4. The student must concentrate his attention on the light shining through the central region of the cornea; the periphery may differ considerably in its refraction owing to spherical aberration.

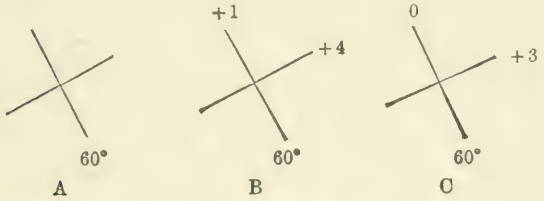
5. In the examples given—one of hypermetropia, the other of myopia—the student has been directed to reduce the reflex of each to the smallest degree of positive movement he can see. This minute positive movement is a definite guide, whereas an attempt to find a vague neutral point is not safe.

Astigmatism in Retinoscopy.—There will be few cases so simple as those in examples 1 and 2. In astigmatism the curvature of the refractive media is not the same in every meridian. Usually the cornea is more sharply curved from above downwards than from side to side. This inequality of curvature has its effect on the light reflex. Instead of coming from the eye round and full as from a good lantern, the reflex is elongated, becomes a line of light—a 'pillar of fire' is no bad simile—and this line shows the axis of the astigmatism. The movements of the light will be the same as before, either positive or nega-

tive ; but we must watch these movements along the lines of the light—*i.e.*, the axes of the astigmatism.

Example.—The line of light lies obliquely—say from XI to V on the clock face. If we consider the vertical line to mark 90° on the circle, this oblique line will mark 60°, so mark out a cross, as at A (see below).

Now work out the value of the reflex in each of the meridians. Suppose the result to be + 1 in the nearly vertical line and + 4 in that nearly horizontal, mark as at B. If we correct these results for the error of our working distance the reading will be as marked at C—that is to say, the eye requires a + 3 D cylinder, axis 60° down and out, to correct the error of refraction.



Cases will vary greatly. In some the student will find the light shines from the eye round and full at first, but as he works it out with spherical lenses there will appear a line of light in some axis, indicating some degree of astigmatism as well as of spherical error. In others he will find one meridian show a positive reflex, the other a negative reflex—*i.e.*, a mixed astigmatism ; he will work out each axis independently, and mark out a cross giving the axes and the value of each axis.

'Scissor' Movement.—In certain cases of myopic astigmatism two reflexes will be seen when the mirror is moved vertically ; one will be positive, the other negative, so they move against each other like scissor-blades. These cases are very difficult to correct ; it is well to work out the reflex of lesser myopia.

Must a Cycloplegic be used before Retinoscopy?—The case varies with the age of the patient

1. *Children up to Fourteen Years.*—Since the accommodation of a child is powerful, a cycloplegic is necessary to ascertain the true refraction. A 1 per cent. atropine ointment placed within the eyelids three times a day for three days is very efficient.

2. *Young Adults.*—Up to thirty-five years in many cases a cycloplegic is necessary. The best for these patients is a solution of the alkaloids of homatropine 2 per cent., and cocaine 2 per cent. in castor oil. (Solution can be obtained by warming gently over a water-bath for about six hours.) A small drop placed in the lower fornix with a glass rod will secure paresis of the accommodation in an hour The effect can be neutralized in thirty minutes by using 1 per cent. of eserine in castor oil in the same way.

3 *In Adults and Elderly Patients* retinoscopy can be performed without a cycloplegic if the pupils are of sufficient size, because the accommodation is negligible after forty years. A mydriatic is sometimes necessary for the complete examination of the lens or fundus. The 1 per cent. solution of homatropine and cocaine in castor oil is sufficient.

It is most important to take the tension of the eye before using a cycloplegic in patients over twenty-five years, and the effect should be subsequently neutralized by eserine to avoid risk of glaucoma.

Objective Demonstration of Corneal Astigmatism.—A high grade of inequality of curvature may be seen by looking at the eye from the side. It can be more easily seen by the use of instruments which reflect definite markings upon the cornea.

Placido's Disc (see Figs. 38 and 39).—The side marked in circles is placed near to the patient's eye; a light placed to one side of the patient shines on the disc. The surgeon looks through the central hole (which is glazed + 4 D to give magnification), and sees the images of the circles on the cornea. In astigmatism the circles are ⬭ instead of ○, and the axis of the obliquity is that of the astigmatism. In corneal opacities the images of the circles are broken and irregular.

Ophthalmometer.—Helmholtz devised an instrument based on the foregoing principle wherewith to measure the degree of corneal astigmatism. It has great scientific value, but since the astigmatism of the cornea is not the same as that of the lens, either in axis or degree, it cannot give the total astigmatism of the eye, so it is of little or no value in practice.

XXIII. SUBJECTIVE DETERMINATION OF REFRACTION.

This is part of the usual routine in refraction work, and normally follows the objective examination by retinoscopy; then it is used to check the results obtained by retinoscopy, and to ascertain what improvement will be obtained by such glasses as it is proposed to order. In young children and illiterates a subjective examination is impossible; hence the necessity for such a mastery of retinoscopy as will enable a satisfactory prescription to be written on the findings of retinoscopy alone.

If retinoscopy cannot be performed in any case, by reason of a minute pupil and the contra-indication of a mydriatic, we must do the best we can by trying various glasses on the patient, with the help of such devices as will enable the patient to make clear his defect to us.

Stenopœic Disc.—This is a most useful device. Suppose a patient's vision is bad ($V = \frac{6}{60}$), the defect may be due to a diseased eye or an error of refraction; we can determine this by placing before the eye a stenopœic disc, a metal or card disc, with a small central hole, 1 millimetre diameter.

If the patient looks through the hole and sees no better, vision is bad because the media or fundus are diseased.

If the vision is improved by looking through the small hole, then there is an error of refraction, for the disc acts to the eye as does a pinhole camera to the sensitive plate—it cuts off the aberrant rays and diffusion circles of the bad focus and allows a clear image to fall upon the retina. For example, a myope of 3 or 4 D with visual acuity of less than $\frac{6}{60}$ will read $\frac{6}{6}$ fairly easily through the pinhole.

Trial with Spherical Lenses.—Try plus lenses first; if these do not aid vision try minus lenses; always try to find the **highest plus** lens or the **lowest minus** lens the vision is best with. If the vision in each eye be improved to $\frac{6}{6}$ all may be well, but before concluding try both eyes together to determine if plus lenses can be increased or minus lenses diminished. Whatever the patient may be wearing, put up + 0·5 before each eye; if he sees as well, try + 1. This is to make as sure as can be that the patient is not using his accommodation.

NOTE.—The student should try on himself how easily minus lenses are tolerated when they are not required. If he be emmetropic and sees $\frac{6}{6}$, he can put on – 1, – 2, – 3, or more minus lenses, and see quite well, because he neutralizes them with his

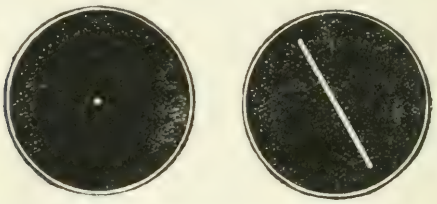


FIG. 57.—Stenopœic disc and slit. (× $\frac{3}{4}$.)

accommodation. But he will not tolerate + 0·25 D, unless he be hypermetropic, for he cannot neutralize a plus lens.

Astigmatism.—If the vision cannot be improved to $\frac{6}{6}$, there may be astigmatism. It may also be present in low degree when $\frac{6}{6}$ can be read.

There are numerous methods of making the effects of astigmatism evident to a patient, and so guide us in its correction.

1. *Astigmatic clocks*, or charts, can be had with lines radiating from a common centre; if, when these lines are viewed at a distance, some are clear, others hazy, there is astigmatism. The clear lines lie in the meridian of worst vision. Cylinders should be tried with axes at right angles to these lines until all are equally clear.

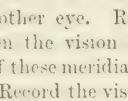
2. *Luminous points*, circles of light, or the distant moon, when viewed by an astigmatic eye, are not circular but oval. Try cylinders set with axes across the narrowest part of the oval.

3. *Stenopeic Slit.*—There is no method so speedy and accurate as the use of the stenopeic slit (a disc of metal cut through its centre by a slit a millimetre wide). It is far superior and more accurate than estimation by the use of 'clocks,' marked letters, luminous points, etc. It is much more expeditious than the use of cylindrical lenses.

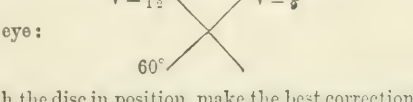
Donders, in his classical work ('On the Anomalies of Accommodation and Refraction of the Eye,' p. 479 *et seq.*, Sydenham Society's Transactions), discusses ten methods of estimating astigmatism, and accords the stenopeic slit premier position for expedition and accuracy, placing the use of cylindrical lenses second as a means of checking and refining the results obtained with the slit. It must be remarked that retinoscopy was unknown at the date of his writing.

To use the slit, place it in the cell of the trial frame before the eye; obscure the other eye. Rotate the slit, asking the patient to cry out when the vision is (1) at its best, (2) at its worst. Note the axes of these meridians; they should be at right angles to each other. Record the vision in each meridian thus:

Right eye:



Then, with the disc in position, make the best correction possible for each meridian separately with spherical lenses, and add to the record, thus:



$$\text{or correction} = \frac{+\ 1\ \text{D sphere}}{+\ 1\ \text{D cyl. ax. } 60°}$$

Check the results by trial with these lenses.

Jackson's Crossed Cylinders.—Two cylinders of opposite signs with axes set at right angles ground on the same lens. Very useful for testing small differences in cylindrical corrections. Place such a lens in front of the lens chosen, first with one axis and then the other axis coincident with the axis of the trial lens, and ascertain effect. The crossed cylinder in one position will add to the chosen cylinder, and in the other reduce it.

XXIV. PRESCRIBING GLASSES.

After Subjective Examination.—The data before us are: (1) The age and work of the patient. (2) The distant vision of each eye separately. (3) The glasses found to give best vision. (4) The best vision obtainable. If the data are relatively consistent we may order the glasses on trial; if there is inconsistency objective examination must be insisted upon. (Examples on these points will be found in Chapter XXVII.)

In hypermetropia give the highest plus lenses with which full distant vision can be got with both eyes open.

In myopia give the lowest minus lenses with which best distant vision can be got with both eyes open. (See further in Chapter XXV.)

In astigmatism give the weaker of two cylinders that give equally good vision, and where axes are different in the two eyes modify rather than accentuate the difference.

In anisometropia diminish rather than accentuate the difference: try with both eyes open the effect of slightly increasing the weaker lens or reducing the stronger.

In presbyopia data 1, 2, 3, and 4 will have been obtained; also 5, the patient's near-point (p. 115) with his distance glasses. Correct the near-point to the distance required by his near work, by adding + spheres: bring it to 12 inches for a man who reads all day; keep it to 24 inches for a woman who works standing at a table, or for a painter or carpenter. A hypermetrope retains active accommodation muscles longer than a myope (Fig. 58) and, provided his H. is corrected, desires a smaller presbyopic correction than age would suggest. In any case do not over-

correct presbyopia, for a short near-point necessitates excessive convergence which is fatiguing.

After Objective Examination.—When the refraction of an eye with cycloplegia has been worked out by retinoscopy, and corrected for working distance, the real refraction of the eye is known. Given a reliable retinoscopy it is possible to order the glass required without subjective tests; this has to be done in young children, and sometimes with illiterates. The student should aim at such a mastery of retinoscopy, and judgment of the conditions of a case, as will enable him to say what will be the best glass for any variety of refraction.

The difficulty of judgment is greatest *in hypermetropia;* there is little in myopia or astigmatism.

In myopia give the full correction determined by retinoscopy, with the exceptions given in Chapter XXV.

In astigmatism.—In low degrees order the exact correction, in high grades order slightly within the figure measured. Astigmatism is very common, and frequently low degrees cause headache, especially when the *axis is against the rule.* In young children, when there is much hypermetropia, combined with a low degree of As., the latter may be neglected, at any rate for the first glasses, unless there be squint. As. of 1 D., or more, should certainly be corrected.

Hypermetropia accounts for fully 90 per cent. of errors of refraction, either alone or in combination with astigmatism. The order to be given for an equal degree of H., as measured by the corrected retinoscopy, will vary with the age of the patient—*i.e.*, with the activity of the accommodation when that is in full action.

Commonly one hears of the necessity of 'allowing for the atropine.' That is wrong; if allowance had to be made for the cycloplegic, it would be needed equally for all types of refraction, and in patients of all ages, but it is not. Myopia and astigmatism are not equally affected, nor is hypermetropia at every age.

Children, say up to fourteen years of age. At this age accommodation is powerful and active. In H. the muscle is

hypertrophied, and its activity greater than normal, because of the necessity for accommodating to get clear distance vision as well as near (Fig. 58).

FIG. 58.—Sections through the ciliary region of—

E, Emmetropic eye. Note the relation of the longitudinal and circular (black) muscle fibres.
H, Hypermetropic eye Note the hypertrophy of the circular fibres.
M, Myopic eye. Note the atrophy of the circular fibres.

Accommodation tends to fail in ill-health, or after excessive work; then inquiry discovers the error of refraction. We must

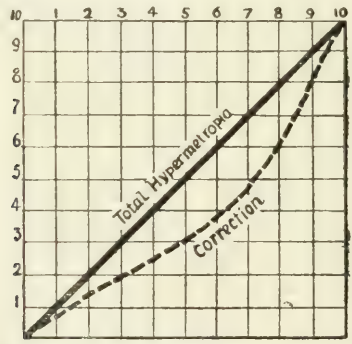


FIG. 59. — The relation of the total hypermetropia, as measured by retinoscopy during cycloplegia, to the average necessary correction for children of school age.

correct the H. in relation to the probable hypertrophy of the muscles. Fig. 59 shows graphically the average allowance for accommodative activity with each degree of hypermetropia. It

will be noticed that there is a large allowance in the middle figures—*e.g.*, H. = 6 D order 4 D—but at the extremes little or no allowance is wanted—*e.g.*, H. = 1 D order 1 D or 0·75 D; H. = 10 D order 10 D. In low degrees of H. with eye fatigue the correction may be allowed for near work only. In middle degrees the accommodation is usually good, so due allowance should be made, and the glasses worn constantly or throughout the school day. In high degrees of H. accommodation becomes impossible, the child acts as though he were short-sighted, so a full correction is necessary for constant wear.

An exception to this rule occurs in **Squint**, where a full correction within 0·5 D should be ordered irrespective of the degree of H. to promote relaxation of accommodation and convergence. Continue use of atropine a fortnight after first use of the glasses to make full correction tolerable.

In *young adults* much less allowance is required for accommodative activity, and if glasses have been worn in early years no allowance may be required, especially if the glasses be wanted for near work only.

In *adults* the total and manifest hypermetropia agree.

XXV. MYOPIA.

Myopia is no mere error of refraction; it is a disease which needs special consideration. Defect in distant vision is the commonest symptom, and if the short-sight be more than of very moderate degree, it will be found that the patient holds print nearer than normal to the eye. Myopia is due to stretching of the globe, which may often be detected by the prominence of the eye or the great extent of sclera exposed on looking sideways. In high degrees there is nearly always bulging of the sclera at the posterior pole—*i.e.*, just outside and around the optic disc. This bulging is accompanied by an atrophy of the choroid covering it, and with the ophthalmoscope a whitish crescent, circle, or large irregular patch, will be seen; the crescent is usually to be seen at the outer side of the disc. The term 'posterior staphyloma' is applied to the bulging. The choroid is generally thinned and its vessels more obvious than usual, and in some cases patches

of choroidal atrophy are present in the yellow-spot region. It is possible that the increase of myopia may be determined by the pressure of the recti muscles upon the globe during the excessive convergence required by the short focus of these eyes; for that reason glasses to reduce convergence are a necessity. The increase, as a rule, does not occur after about twenty-five years. Any severe illness, and especially congestion of the eyes brought about by excessive strain in near vision, and stooping over books, etc., favours its progress.

In high myopia there is a tendency to several complications, all seriously damaging to the sight. These are: (1) opacities in the vitreous, 'muscæ volitantes,' or floating spots of irregular shape, a very common symptom, even though no opacities can be detected by the surgeon; (2) hæmorrhage into the vitreous or retina after slight blows, or coming on spontaneously; (3) detachment of the retina; (4) choroidal atrophy, or 'central choroiditis'; (5) abnormal fluidity of the vitreous; and (6) secondary cataract, especially of the posterior surface or pole of the lens.

The rate of increase of myopia varies much amongst its subjects; sometimes a low degree (*e.g.*, – 3 D) coming on about puberty persists throughout life. In these cases we rarely find a marked crescent round the disc, and beyond the defect in distant vision such an amount of short-sight entails no disadvantage. Indeed, as soon as the presbyopic age (forty-five) is reached, it is a slight advantage, since glasses may not be required for near vision until about fifty-five or sixty years. More commonly myopia commences in childhood and steadily increases; the eyes are frequently weak and irritable, and such complications as blepharitis or chronic conjunctivitis are not infrequent. The muscular weakness or 'asthenopia' has already been considered, as well as the graver complications.

The Treatment of Myopia.—Perhaps the most frequent determining cause of an increase of myopia is excessive convergence. We may prevent this by giving glasses that correct the myopia, and therefore push the near-point of vision farther from the eyes. To-day most surgeons agree in prescribing

glasses that provide a ' full correction ' of the myopia. This is a good rule with certain limitations.

It must be remembered that a concave lens lessens the size of an image, and hence when a high lens is ordered the patient finds that print is rendered so small that it is impossible to use the glasses for near vision. It is generally found that up to – 4 D or – 5 D the glasses can be comfortably worn in near vision, and if this is the total myopia they may be ordered for constant use. Above this degree the full correction, or nearly the full, may be ordered for use in distant vision, and that glass (usually – 4 D or – 5 D) which will enable the subject to avoid bringing the book nearer than 10 inches, for use in near vision. To avoid the trouble of changing the spectacles Franklin or bifocal lenses may be ordered. If the patient's eyes are irritable in ordinary sunlight, it is a good plan to order the proper lenses in neutral-tint glass. In any case of myopia the patient should be warned against reading in a bad or unsteady light (*e.g.*, in railway carriages and at night), against stooping over his work, and against continuing work after the eyes begin to ache. If he be out of health, tonics and a holiday should be ordered. The quality of the print is considered to be an important factor, and may account partly for the great prevalence of short-sight in Germany. The best position for natural or artificial light in reading or working is on the left side, and so placed that the rays fall on to the book or work, and not into the patient's eyes (see chapter on 'School-Children ').

Removal of Lens in High Myopia.—In myopes of over 20 D, where vision cannot be much improved by glasses, extraordinary improvement of vision has been obtained by removal of the crystalline lens. The operation for soft cataract is performed, but the posterior capsule should not be needled, lest the vitreous be involved. Only one eye should be done, and then only where the fundus is healthy, for there is some evidence that the operation increases the liability to detached retina.

Myopia Due to Rarer Causes.—(1) Abnormality of the lens

ligament, either from traumatic or congenital defect. A tilting backwards of the lens causes myopia.

(2) Senile sclerosis of the nucleus of the lens causes myopia; it is an early sign of cataract.

XXVI. THE FITTING OF GLASSES.

A great deal of the value of glasses depends upon the position of the lenses before the eye. The skill of an optician is determined by his capability of fitting the most difficult face. Certain data should be supplied to him, besides the description of the lenses, as these will vary as a patient is tall or short, and the glasses are required for distance or near work.

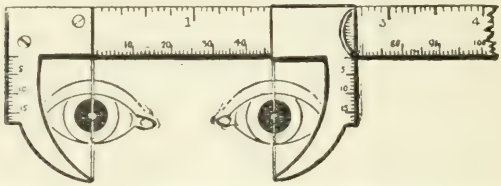


FIG. 60.—Harman's ophthalmic calipers for measuring the ocular base-line.

The Ocular Base-Line.—The width between the visual axes of the two eyes. It varies considerably; in children it measures from 45 to 55 millimetres, in adults from 55 to 75. It is wider in broad heads (brachycephalic) than in long heads (dolichocephalic). The base-line should be measured in distant and in near vision. This can be easily done with calipers. The patient looks at a light in the distance, and the observer sights with his own left eye the wire of the calipers against the spot of light on the patient's right eye, and with his own right eye sights the other wire over the spot of light on the patient's left eye. For near vision the patient fixes a near-point, and the distance between the corneal images of the light are taken as before. The inter-pupillary distance is an unsatisfactory measure, as it takes no account of the angle alpha (p. 145).

Position of Lenses in Spectacles. — The centring of the lenses is determined by the ocular base-line. Correct centring is of much importance, since lenses act as prisms. A plus or convex lens represents two prisms base to base. A minus or concave lens represents two prisms apex to apex. A prism displaces a ray of light passing through it towards its base.

FIG. 61.—Diagram to show how spherical lenses, concave and convex, are made up of prisms.

In most patients we want to facilitate convergence or ease of adjusting the eyes for near work. We can do this best by slightly displacing the centres of the lenses ordered, bringing a plus lens inwards and a minus lens outwards. By this means the plus and minus lenses both give the effect of prisms base inwards, and convergence is aided.

FIG. 62.—The author's method of fastening spectacles on infants.

Children's Glasses.—It is better to order round lenses; the child cannot look over a round lens, but must look through it; the axes of cylinders can be easily adjusted.

For children under seven years of age spectacles tied on with

tape are preferable to 'curl sides.' Let the side pieces, or 'bows,' end at the top of the ear in a large loop ; put a length of tape under the nucha, thread each end through the loop of a bow, and tie the tape on the vertex. The tape will secure the glasses and allow sufficient play to prevent nose and ears being hurt. Over seven years of age curl sides (made of fine spiral springs), to curl round the ear, are requisite. When cylinders are ordered the frames must be highly tempered to prevent bending of the bridge.

Adults' Glasses.—For constant wear curl sides are best for men. For women they are uncomfortable, for the wires get caught in the hair, so it is better to order plain bows. There are a variety of patterns of *pince-nez*, with rims and without rims ; some patterns are very satisfactory. When it is necessary for women to wear distance glasses it is well to draw their attention to these fittings, so as to reduce their objection to glasses. *Pince-nez* are fragile and need frequent attention, especially when cylinders are worn ; they sometimes cause epiphora by displacing the puncta.

The Plane of Lenses.—Tall people look down upon things ; it is well to lower the centres of their lenses slightly and cant the plane of the lenses downwards. Spectacle bows are 'angled' to allow of this. Under no circumstances should lenses be canted upwards ; the effect is most uncomfortable.

Reading Glasses.—The centres should be dropped low, for the eyes turn down ; and closer together than for distance, for the eyes turn in. The lenses should be canted 15° to 20°, so that they are at right angles to the downward line of vision.

For presbyopes, 'pantoscopic' spectacles with ⊃ shaped lenses are useful ; it is easy to look over such a lens for distant vision.

Bifocals, or Franklin lenses, are useful when different strengths are required for distant and near vision. They were invented by Benjamin Franklin. There are many beautifully worked varieties on the market ; they are costly, and many patients fail to get used to them ; therefore, in a first attempt, caution the patient and order the cheapest pattern.

Cataract Glasses.—When the crystalline lens is removed

from an eye previously emmetropic, a glass lens in a spectacle frame of + 10 D or thereabouts is required to correct the focus of the eye for distance. For near work an additional + 4 D is wanted. After operation there is usually some astigmatism *against the rule*, + 1 D to + 4 D : cylinder axis horizontal.

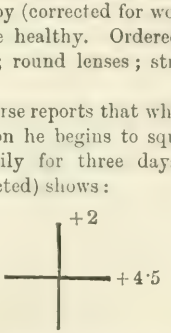
Periscopic Lenses.—When spherical lenses of any strength are required the area of clear vision is limited ; the stronger the lens the more the spherical aberration of the edge of the lens. This distortion can be reduced by grinding the lens so that it is a meniscus, and setting it with the concavity next the eye. In ordering spheres combined with cylinders, this effect can be obtained to some extent by ordering, as the case requires, either a + cylinder with a − sphere, or a + sphere with a − cylinder, in each case with the minus lens next the eye. Toroidal lenses are meniscus lenses with a cylindrical curve ground on the spherical surface of one side. They are costly, and in the higher grades too heavy for comfort.

XXVII. EXAMPLES IN REFRACTION.

Infants.—Under seven years of age.

1. Child, aged 9 months, shows left internal squint ; atropine ointment ordered ; retinoscopy (corrected for working distance) shows 4 D of H. ; fundi are healthy. Ordered + 3·5 sphere for each eye, constant wear ; round lenses ; straight bows, to tie on as described p. 135.

2. Child aged 4 years. Nurse reports that when playing with picture-books in the afternoon he begins to squint. Atropine ointment ordered thrice daily for three days ; pupils well dilated. Retinoscopy (corrected) shows :



Ordered this correction, less 0·5 D sphere, for constant wear ; round lenses ; highly tempered frames to tie on.

The prescription may read either—

(*a*) R. and L. $\frac{+1{\cdot}5 \text{ D sphere}}{+2{\cdot}5 \text{ D cyl. ax. } | \ 90°}$;

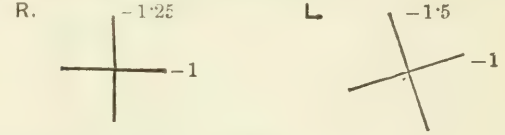
or,

(*b*) R. and L. $\frac{+4 \text{ D sphere}}{-2{\cdot}5 \text{ D cyl. ax. } —0°}$.

The power of *a* and *b* is the same; but *b* gives a periscopic effect when the cylinder is placed next the eye, so is to be preferred.

School-Children.—Seven to fourteen years of age; all referred by the school doctor for examination of eyes because of failure to pass Snellen's test.

3. Boy, aged 12, top of class; fond of reading. R.V. $\frac{6}{18}$, L.V. $\frac{6}{18}$ partly; screws up his eyes on looking at letters. Atropine three days. Retinoscopy (corrected):



Fundi show small myopic crescents.

Vision under mydriatic:

R. $\bar{c} \ \frac{-1 \text{ D sphere}}{-0{\cdot}25 \text{ D cyl. ax.} —0°} = \frac{6}{6}$.

L. $\bar{c} \ \frac{-1 \text{ D sphere}}{-0{\cdot}5 \text{ D. cyl. ax. } \diagup 10° \text{ Down and In}} = \frac{6}{6}$.

All home work and use of small print inhibited.

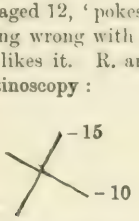
Glasses ordered as above; or transposed thus, and with spheres placed next the eyes, the effect is better:

R. $\frac{-1{\cdot}25 \text{ D sphere}}{+0{\cdot}25 \text{ D cyl. ax. } |}$.

L. $\frac{-1{\cdot}5 \text{ D sphere}}{+0{\cdot}5 \text{ D cyl. ax. } \diagdown 80° \text{ D. O.}}$.

4. Girl, aged 10, eyes get bloodshot after sewing. R.V. $\frac{6}{9}$, L.V. $\frac{6}{9}$. Atropine three days. Retinoscopy (corrected): R. and L. + 4 D sphere. Vision, under atropine, without glasses = $\frac{6}{36}$ each eye, with glasses = $\frac{6}{9}$. Ordered R.L. + 2·5 D sphere for school use only. Seen a month later, vision with glasses = $\frac{6}{6}$.

5. Girl, aged 12, 'pokes'—*i.e.*, carries head forward, mother says nothing wrong with her eyes, can do needlework beautifully, and likes it. R. and L.V. less than $\frac{6}{36}$, atropine three days. Retinoscopy:

R. 

L. −8 D sphere.

Fundi—large myopic crescents, evidences of recent increase. Vision, under atropine:

R. $\bar{c}$ $\frac{-10 \text{ D sphere}}{-5 \text{ D cyl. ax. } 20° \text{ D.I.}}$ = $\frac{6}{18}$.

L. $\bar{c}$ −8 D sphere = $\frac{6}{9}$ partly.

All reading, writing, and sewing stopped. Message sent to school doctor that the child should be transferred to a special school for myopes (these have been established by the London County Council). Ordered full correction. Seen two months later. Vision with glasses—R. $\frac{6}{12}$, L. $\frac{6}{9}$.

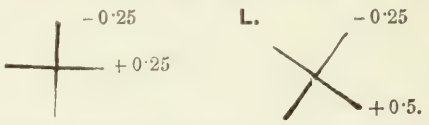
6. Girl, aged 13, 'recent difficulty in seeing things.' Mother says she is working for scholarship, and asks that no 'drops' be used to stop her work. R. and L.V. $\frac{6}{36}$, + spheres worse, − spheres improve to $\frac{6}{12}$. Under circumstances use homatropine and cocaine 2 per cent., and tie up eyes for one hour. Pupils fully dilated. Retinoscopy just + 1 D—*i.e.*, when corrected for distance emmetropic. R.V. without glass $\frac{6}{9}$, L.V. without glass $\frac{6}{9}$. Diagnosis—spasm of accommodation. Must cease school work for the present, atropine ordered twice daily for a week, and a tonic. Re-examined, V = $\frac{6}{6}$. Retinoscopy emme-

tropic; atropine stopped. Re-examined three weeks later, slight photophobia, vision without glasses $\frac{6}{9}$. Re-examined three weeks later, eyes normal, V = $\frac{6}{6}$, allowed to return to school, but home work and sewing inhibited.

Young Adults.—Fourteen to thirty years of age.

7. Girl, aged 17, seamstress, eyes get tired in evening. R.V. $\frac{6}{6}$, Hm. 1 D; L.V. $\frac{6}{6}$. Hm. 1·25 D. Both eyes Hm. 0·25 D more. No astigmatism. Convergence poor. Pupils and fundi normal. The data are consistent; there may be some Hl., but the Hm. and defective convergence explain her eye trouble, and the plus lenses decentred inwards 5 millimetres (p. 133) will go far to relieve it.

8. Girl, aged 17, seamstress, eyes tired in evening. R.V. $\frac{6}{9}$, no Hm., − 0·5 D sphere gives $\frac{6}{6}$ partly; L.V. $\frac{6}{9}$ partly, no Hm., − 0·75 D sphere gives $\frac{6}{6}$ partly. The data are inconsistent. (*a*) So small an amount of My. should not cause fatigue, unless the girl is in bad health; (*b*) with the minus spheres vision is not perfectly corrected. It is likely there is some astigmatism, with possibly a spasm of the accommodation. A cycloplegic is necessary. Homatropine and cocaine 2 per cent. dropped in each eye, eyes kept shut for forty minutes. Pupils fully dilated. Retinoscopy (corrected):



Pupils, media, and fundi normal.

R.V. $\bar{c}\ \frac{-0{\cdot}25 \text{ D sphere}}{+0{\cdot}5 \text{ D cyl. ax. } 90^\circ} = \frac{6}{6}$.

L.V. $\bar{c}\ \frac{-0{\cdot}25 \text{ D sphere}}{+0{\cdot}75 \text{ D cyl. } / \text{ 80 D. I.}} = \frac{6}{6}$.

Ordered these glasses; eserine instilled before dismissal. Seen fourteen days later, patient has no more trouble, V. = $\frac{6}{6}$ each eye with glasses.

9. Labourer, aged 16. Rejected at Navy medical examination. 'Doctor said right eye defective.' R.V. $= \frac{6}{18}$, L.V $= \frac{6}{6}$. Retinoscopy without a mydriatic show R. As. + 2 D axis 20° D. I.' vision with this glass $\frac{6}{6}$ nearly. Such a man would not pass for the Navy, but would pass for the Army. For his own work glasses would be useless, so refraction not further investigated.

Adults.—Thirty to fifty years of age.

10. Dressmaker, aged 35, 'finds black work difficult in the evening.' R.V. $= \frac{6}{6}$, Hm. 1 D ; L.V. $= \frac{6}{6}$, Hm. 1 D, both eyes Hm. 1·5 D. Convergence good. Pupils normal, fundi normal. Ordered +1·5 D sphere for near work.

11. Charwoman, aged 48, 'cannot do her mending in the evening, can see in daytime.' R.V. $= \frac{6}{18}$. Hm. 2 D $= \frac{6}{6}$; L.V. $= \frac{6}{18}$ partly, Hm. 2·5 D $= \frac{6}{6}$. With additional + 1 D sphere over each eye reads Jaeger 1 at 12 inches. She has never worn glasses before, so the full correction for H. and presbyopia will not be ordered, but a trifle less, viz. : R. + 2·5 D sphere, L. + 3 D sphere. Distance glasses would be a nuisance to her, even though they sharpen the vision.

12. An artist, aged 48, finds difficulty in seeing both his model and his canvas. Saw quite well until recently, when he had influenza badly. R.V. $= \frac{6}{12}$, Hm. 1 D $= \frac{6}{6}$; L.V. $= \frac{6}{12}$, Hm. 1 D $= \frac{6}{6}$. Additional + 1 D sphere over each eye gives Jaeger 1 at 18 inches, the usual distance of his canvas. Ordered bifocal lenses, upper segment + 1 D, lower segment + 2 D spherical. Seen a month later the artist says the glasses are splendid for his work, but he cannot walk downstairs with them on, the lower segment confuses the stairs (this is the usual complaint concerning bifocals).

Elders.—13. A needlewoman, aged 68, finds her glasses (R. and L. + 4 D) no use now, she cannot thread her needle. R.V. $= \frac{6}{12}$ not improved, L.V. $\frac{6}{9}$ not improved. Pupils very small, but mobile. Fundus reflex crossed by lines apparently in lens. Tension normal, a minute smear of homatropine and cocaine ($\frac{1}{2}$ per cent.) placed within each lower lid. In thirty minutes pupils dilated to 6 millimetres diameter. Lenses

opalescent, striæ marked. Examined with retinoscopy mirror right eye shows early senile cortical cataract, left eye the same in a fairly advanced stage. Fundi examined as far as possible, appear quite healthy. Patient has to wait until cataract sufficiently advanced for extraction, unless Förster's, McKeown's, or Smith's methods of extraction of unripe cataract be resorted to (p. 207). Eserine instilled before dismissal.

XVIII. SQUINT.

Monocular Vision.—In the lower vertebrates—*e.g.*, fishes—the eyes are lateral in position, and work independently of each other. They seem to serve rather as alarums than as organs of perception. The same holds good for lower mammalia—*e.g.*, rabbits.

Binocular Vision.—Higher in the scale the eyes are placed towards the front of the head—*e.g.*, domestic cat. Then we find the eyes work together, and the visual centres of the cortex are greatly increased in size.

In man the development is complete. The eyes are in front; they work together on parallel axes, and can be converged to examine a near object. There is constant binocular or stereoscopic vision, and with that the ability to determine the size, bulk, and distance of any object. This judgment is effected by an unconscious, but trained, perception of the nerve impulses required by the extra-ocular muscles in moving the eyes.

Fusion Faculty.—Binocular vision depends also upon the faculty of the visual centres of the brain to fuse the images of the two eyes. It is not present at birth. As Pepys puts it in his 'Diary': 'At supper the three doctors of physic again in my cabin, when I put Dr. Scarborough in mind of what I heard him say—that children do, in every day's experience, look several ways with both eyes, till custom teaches them otherwise; and that we do now see but with one eye, our eyes looking in parallel lines.' Binocular fixation usually appears within two to four weeks after birth, but a very little irritation, such as a pin-prick, will cause a baby to squint.

Once binocular vision is well established it is rarely disturbed; but should the fusion faculty be weak, a very little irregularity of one or both eyes will cause squint.

Tests for Binocular Vision. 1. Whilst the patient is reading small type at the distance of 12 inches, slip a thick pencil midway between the eyes and the print; if he has binocular vision he will see the print behind the pencil. This is a rough-and-ready test.

2. The capability of seeing perspective effects with a stereoscope.

3. The diaphragm test, see p. 148. For children there are picture test cards.

4. Hering's drop test: Let the patient look with both eyes through a tube made of brown paper; hold a fine piece of black wire horizontally a short distance from the far end of the tube, and drop small black balls before and behind the wire. If there be binocular vision the patient will have no difficulty in seeing whether the balls fall in front or behind this wire.

Nomenclature of Squint.—*Concomitant* indicates that the two eyes move together, in distinction to the one-eyed movement seen in 'paralytic' squint. *Convergent* indicates that the squinting eye turns in toward the nose; *divergent*, that the eye turns out. The squint is known as *right* or *left*, according as the right or left eye turns in or out; *alternating*, when either eye squints indeterminately; *occasional*, when the squint is intermittent.

Amblyopia.—The squinting eye may become completely blind from disuse: even fixation power may be lost. The images of the squinting eye are suppressed by the brain, to get rid of the annoyance of the diplopia, hence the urgency of treatment for relief of the squint. Vision can be recovered if it be not too far gone or lost for too long a time.

Causes of Squint.—If the fusion faculty be weak, relatively small troubles may cause squint. The most common causes are:

1. *Hypermetropia.*—Convergence and accommodation normally go together. In hypermetropia accommodation has to

be effected without convergence; this effort is too great if the fusion faculty be weak, so one eye turns in and converges for both.

2. *Inequality of the eyes* in refraction or in muscle control.

3. *Corneal Opacities* following ulcers of the cornea from purulent inflammation or phlyctenules.

4. *Fevers or Accidents.*—The disturbance of an acute fever, measles or whooping-cough, or a fall, may determine the onset of squint.

5. *High myopia* tends to cause divergent squint.

Mode of Investigation.—1. Tell the child to look at a pencil held before one's nose; then rapidly cover first one, then the

FIG. 63.—Shows the images of a mirror symmetrically disposed on each cornea in perfect fixation.

other, of the child's eyes, watching if the eyes shift. If both fix simultaneously, the eyes will not shift; if only one fixes, when this eye is covered the other will try to fix, and movement will be seen.

2. Take the child into the dark room; place him back to the light, and throw the reflection from an ophthalmoscopic mirror into his eye. When he fixes the mirror, note the position of the tiny image of the mirror on the cornea of each eye. They should be equidistant from the centre; if one is in a different position to the other, cover first one eye and then the other, and note movement of eye and mirror image (Figs. 63, 64, 65).

Donder's Angle Alpha.—The line of vision of an eye does not coincide with, but lies to the nasal side of, the optical axis of the eye. The difference between these axes is known as the 'angle α' It is about 3° in emmetropia, is larger in hypermetropia, smaller in myopia. Sometimes a large angle is mistaken for a squint, but examination will show that the fixation

does not vary. Landolt's 'angle gamma' differs slightly from this, in that one limb of the angle is taken as the *fixation-line* instead of the visual line.

Integrity of the Muscles.—Fix the head and examine the movements of each eye separately. Let the child follow with its eye the movements of a pencil. The lateral range should be such that the cornea can touch the canthus on either side.

Measurement of Squint by the Perimeter.—Seat the child before the instrument with the chin on the rest. Let an assistant hold a candle in line with, but a yard from, the fixation-point. Note the image of the candle in the centre of

FIG. 64.—Right convergent squint. The left eye fixes, and the image of the mirror is seen in the centre of the cornea. The right eye is turned in 25 degrees, and the mirror image appears close to the limbus.

the fixing eye. Now pass a second candle along the arc of the perimeter until its image falls on the centre of the pupil of the squinting eye. The angle of the squint is shown by the position of the candle on the graduated arc.

Treatment of Squint.—1. Paralyze the accommodation with atropine, and accurately correct any error of refraction by retinoscopy. The glasses should be worn constantly.

2. If after the use of glasses for three months the eyes are not straight, we must exercise the squinting eye.

(*a*) If the squinting eye retains power of fixation, instil atropine into the good eye only. By this means accommodation is lost to the good eye, and the squinting eye is compelled to act in near vision. The good eye should be covered up for a couple of hours each day.

(*b*) *Occlusion of the Fixing Eye.*—If fixation be lost in the squinting eye, attempts may be made to regain it by cutting off the vision of the good eye for one, or at most two, months. Put over the good eye a small pad, and secure it with strapping.

3. *Stereoscopic Exercises.*—When the treatment described is partly successful, exercise with the stereoscope is valuable. Instruments which allow of adjustment to the angle of the squint have been devised by Priestley Smith and Worth.

The diaphragm test is useful in exercising the vision of the defective eye when the deformity of the squint is reduced.

4. *Operation.*—Should be performed to correct the deformity :

I. In older children or adults when the squint is incurable because the squinting eye is amblyopic.

II. In alternating squint when it is judged that fusion may be assisted by a readjustment of the muscles.

III. In monocular squint :

(*a*) When by occluding the good eye the squinting eye becomes the fixing eye (see No. 3 above).

(*b*) When there is sufficient vision in the squinting eye to suggest that it will keep straight if it be put straight.

FIG. 65.—Divergent squint, 'neuropathetic' type. Right eye diverges 15 degrees, especially in evening when fatigued.

In group I. the operation is done for cosmetic reasons only ; in groups II. and III. to recover binocular vision.

Prognosis of Convergent Squint.—1. When associated with an error of refraction and treated early, there is excellent prospect of recovering binocular vision. If fixation of the squinting eye be lost, and the child be over seven years of age, binocular vision is incurably lost.

2. When *alternating*, and with error of refraction, there is fair prospect ; if with no error of refraction, it is incurable without operation.

3. When due to serious *corneal opacities* of one eye, it is incurable without operation; if the opacity cause an astigmatism that can be corrected, the prospect is fair.

Prognosis of Divergent Squint.—1. When associated with low degrees of myopia, prognosis is good when glasses are worn.

2. In high myopia prognosis is bad : the near-point becomes so close that convergence is excessive and difficult to maintain.

3. The occasional divergent squint of eyes with normal refraction is of central origin ; it is frequently hereditary. It is mostly seen in women, and comes on in the evening, especially during fatigue or illness. The patients are quite unconscious of the squint, but when told of it the wandering eye promptly fixes. By means of the Diaphragm Test the defect can be made manifest to the patient and exercises to develop the weak fusion faculty started.

Blind eyes usually diverge. In sleep the eyes diverge upwards and outwards.

XXIX. MUSCLE BALANCE AND CONVERGENCE.

Muscle Balance.—In a normal subject the eyes should be so perfectly balanced in binocular vision that there is no consciousness of effort (orthophoria). In a considerable number of persons the balance is not perfect (heterophoria) ; the fusion sense prevents squint, but the effort to balance the unequal muscles causes frontal headache.

When the eyes tend to turn in = esophoria.
When the eyes tend to turn out = exophoria.
When one eye tends to turn up and the other down = hyperphoria.

Testing the Balance in Distant Vision.—The simplest test is that provided in Maddox's rod. This instrument is a glass rod or several glass rods mounted in a disc ; it has the effect of turning a spot of light or a candle flame into a long line at right angles to the rod. Put on trial frames ; place the rod in one cell ; look at a candle. The flame will be seen with one eye, the line with the other. Now rotate the rod in the cell. If the line always runs through the flame, there is perfect muscle balance ; if it does not, we shall detect by the separation and position of the images any tendency the eyes have to fall away from binocular vision. The separation of the images can be measured upon a tangent scale set up behind the light,

the patient states at what degree on the scale the line of light falls. The appearance of spot and line of light in all conditions is given in Fig. 66.

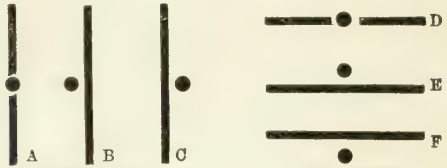


FIG. 66.—Test with Maddox's rod.

● represents the spot of light seen with the left eye, and ▬ the line of light seen through the *rod over the right eye.*

A, Line runs through the spot = orthophoria.
B, Images separate, latent convergence = esophoria.
C, Images separate, latent divergence = exophoria.
D, Line runs through spot = orthophoria.
E, Images separate = right hyperphoria.
F, Images separate = left hyperphoria.

Testing the Balance in Near Vision.—The Diaphragm Test is a most useful instrument for this purpose. Its principle is simple—looking through a small window at a test-card. The position and size of the window are such that a small middle part of the card is seen with both eyes simultaneously (binocular vision), and the wings by a single eye only, and in crossed vision (Fig 68).

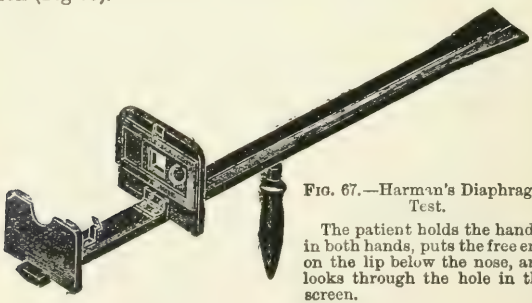


FIG. 67.—Harman's Diaphragm Test.

The patient holds the handle in both hands, puts the free end on the lip below the nose, and looks through the hole in the screen.

Before testing muscle balance it is necessary to correct exactly any error of refraction; this is particularly necessary in near vision for which also any lack of accommodation must be remedied. The patient then holds the instrument in position and reads the test-card. Take a simple test:

123456789

If there is *orthophoria* the patient reads this easily; 1234 are seen by the right eye; 5 is seen by both eyes, the two images being accurately superposed; 6789 are seen by the left eye. The patient has no knowledge of the manner in which the vision is dissected.

FIG. 68.—The Paths of Vision through the Aperture of the Diaphragm Test.

T, Test-card; D, screen with aperture; R and L, eyes; *, the band of binocular vision or ocular-poise.

If, however, there is heterophoria, there is inaccuracy in reading; thus: in *esophoria*, latent convergence, a patient will see

12356789 or 123459

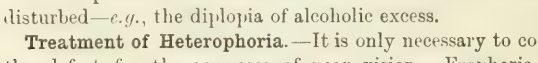
the figure 4 in one case and 678 in the other are lost by overlapping and suppression of images; according to the number of letters lost we judge of the severity of the defect.

In *exophoria*, latent divergence, the patient will see

12345 56789

The eyes have wandered; the images are separated to a greater or lesser degree; 5 is seen twice, for the images of the right and left eyes are not fused.

In *hyperphoria*, latent vertical squint, the patient will see the two parts separately and on different levels, thus :



Left hyperphoria. Right hyperphoria.

In one pattern of the diaphragm test the aperture in the screen is variable, so that the 'ocular-poise' can be varied, and the least width necessary to keep the eyes in good balance measured. Binocular vision is one of the highest faculties of cerebro-muscular co-ordination. It varies in different persons, and in the same person in different conditions of health. It is easily disturbed—*e.g.*, the diplopia of alcoholic excess.

Treatment of Heterophoria.—It is only necessary to correct the defect for the purposes of near vision. Esophoria and exophoria are constantly variable. Minor degrees may be corrected empirically with prisms.

Hyperphoria is a more stable defect ; it is much less common, but causes more disturbance. It may be measured exactly and corrected by an appropriate prism ; a special test-card is supplied for use with the diaphragm test which specifies the prism.

Prisms should be set base IN for exophoria.
base OUT for esophoria.
base DOWN over the hyperphoric eye.

A prism over 3° in one eye, or 4° divided between the eyes, is not well tolerated ; if glasses are worn ordinarily, the necessary prismatic effect may be obtained by decentring the lenses (p. 133).

In severe cases of heterophoria it is necessary to readjust the balance by advancing an appropriate muscle.

Power of Convergence.—In distant vision the eyes are parallel ; in near vision they converge. The capability of converging the eyes varies in different people : some can fix an object close to the tip of their nose ; others cannot fix an object unless it be a foot or more away.

If convergence cannot be maintained with ease at a com-

fortable reading distance (12 inches) headache will surely be complained of.

Treatment.—Practice convergence daily. For near work, especially in old people and severe cases, give the help of weak prisms, base in.

XXX DISORDERS OF ACCOMMODATION.

The ciliary muscle (supplied by the third nerve through the lenticular ganglion) draws forwards the suspensory ligaments of the lens, and by so doing allows the elasticity of the latter to render it more convex (accommodation). The contractor pupillæ is supplied by the third nerve; the dilator muscle fibres of the iris are supplied through the medium of the sympathetic nerve. Cases occur in which the internal muscles are paralyzed (ophthalmoplegia interna), others in which both internal muscles and external muscles are paralyzed (ophthalmoplegia totalis), or only the external muscles may be effected (ophthalmoplegia externa). Both paralyses may occur at the same time.

1. **Age.**—Power of accommodation declines naturally with age. Owing to the progressive growth and hardening of the lens, its shape gets more and more fixed (see Presbyopia, p. 116).

2. **Mydriasis.**—The power of the internal muscles may be temporarily suppressed by use of drugs—mydriatics and cycloplegics: atropine, homatropine, hyoscyamus, and duboisine. Miotics: eserine, etc., tend to neutralize this action.

3. **Disease** or exhaustion may produce the same effect. From peripheral neuritis after diphtheria or influenza; in the lesions of syphilis; in brain disease; in bodily exhaustion, as from prolonged suckling; or as a direct effect of contusion of the eyeball.

Symptoms.—There is inability to read. Most marked in hypermetropes, in whom also distant vision may be defective. It affects myopes little or not at all.

Treatment.—Where the lesion is peripheral, as after diphtheria, tonics, especially strychnine, should be given. Where

from central lesions, as in syphilis, mercury or iodides. Where from contusions, recovery is unlikely. Glasses may be given where the disturbance is prolonged.

Spasm of Accommodation occurs in weakly, overworked children and young girls where there is some error of refraction. There is blurring of vision after work. On examination they appear myopic, but after the use of a mydriatic they may be found to be really hypermetropic.

Treatment.—Mydriatics, tonics, good food, and rest.

The Sympathetic.—The ocular fibres of this nerve come out from the spinal cord by the first or second dorsal nerve, and then join the cervical sympathetic trunk, to reach ultimately the lenticular ganglion in the orbit by means of the carotid plexus. If the branch to the eye be paralyzed (from pressure of a tumour or aneurism in the neck, injury to the sympathetic cord in operations, rupture of the brachial plexus, etc.), the pupil is slightly contracted, *and it will not dilate on shading the eye.* The palpebral fissure may be slightly narrowed (pseudo-ptosis), and the globe a little less prominent than on the other side (enophthalmos)—due to loss of action of unstriped muscle in the upper lid and orbit. The intra-ocular tension is diminished. Pinching the skin of the neck no longer causes the pupil to dilate; and the normal effects of an instillation of cocaine into the conjunctiva (dilation of pupil, slight retraction of upper lid and protrusion of the globe) are lost.

XXXI. PARALYSIS OF THE EXTERNAL MUSCLES OF THE EYE.

Nerve Supply and Functions.—Of the external muscles of the eye, the levator palpebræ, superior, internal, and inferior recti, and the inferior oblique, are supplied by the third nerve. The external rectus is supplied by the sixth nerve, the superior oblique by the fourth.

The superior rectus acting alone turns the eye upwards and inwards, rotating the vertical meridian slightly inwards (Fig. 70).

The inferior rectus alone turns the eye downwards and inwards, rotating the vertical meridian slightly outwards.

The superior oblique alone turns the eye downwards and outwards, rotating the vertical meridian slightly inwards.

The inferior oblique alone turns the eye upwards and outwards, rotating the vertical meridian slightly outwards.

The internal and external recti simply turn the eye inwards and outwards.

In considering the movements of the eye it must be remembered that the muscles act in pairs or groups in producing any

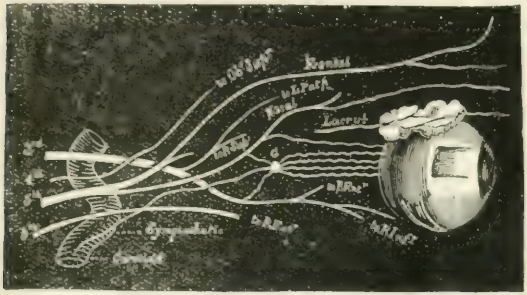


FIG. 69.—Diagram of the Nerve Supply to the Eye.

one movement ; thus, for instance, in looking straight downwards we use the inferior recti and superior oblique ; in looking downwards and outwards with one eye, the external and inferior recti and the superior oblique come into play. It will be noticed that the tendency of the superior rectus to rotate inwards and to adduct is modified by that of the inferior oblique to rotate outwards and abduct, the resulting action being one of simple elevation.

In health both eyes move simultaneously, either in parallels (as in viewing distant objects) or in converging lines (as in examining one's finger). In disease one or more muscles may be paralyzed ; the movements are lost ; the balance of the eyes

is upset; each eye sees its own image unfused, and there is double vision or diplopia

The diagnosis of these defects is difficult, but if the student

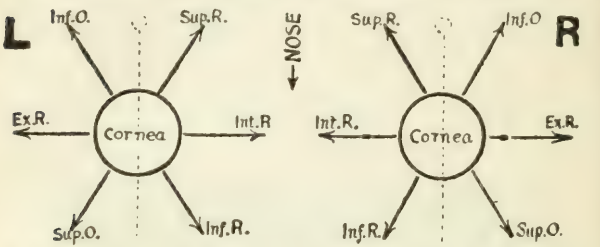


FIG. 70. — Diagram of movements of eyes. Patient's view. Muscles move the eyes in direction of arrows. To demonstrate rotation, place a match, head upwards, on each diagram on the dotted line which represents the 'vertical meridian' of the eye. Muscles that rotate the eye inwards bring the match-head towards the nose, as Sup.R. and Sup.O.; those that rotate outwards bring the match-head away from the nose, as Inf.R. and Inf.O.

For use of the diagram in diplopia, see p. 159.

The student should not attempt to learn this diagram, but he should be able to build it up from his knowledge of the muscles. Begin by marking the easy muscles, internal and external recti, and then proceed to the more difficult; after a little practice the diagram will be found quite easy to build up. He should copy it out in large size for reference in studying the succeeding pages.

will thoroughly familiarize himself with the normal movements of the eyes, by studying a good model, he will find difficulty and confusion give place to facility and interest.

Mode of Examination for a Paralysis.

Objective Tests (I., II., and III.):

I. *Note the Manner in which the Man holds his Head.*— Suppose all the eye muscles were paralyzed, the loss of the eye movements would be supplied by the neck muscles moving the head. Just so in a single paralysis. Say the right external rectus is paralyzed; the man holds his head so as to make up for this loss; his head is turned to the right. The like holds

good for any other single muscle (see diagram). Exceptions: permanent wry-neck, old paralyses.

II. *Note the Movements of the Eyes.*—Let the man look at a pencil; move it so that the eyes follow each of the lines of the diagram, and note any defect of movement of one or other eye in any of these directions. Weakness is sometimes indicated by nystagmus or jerkiness at the extremes of direction.

III. *Deviation.*—(1) Primary: If all the muscles of an eye were paralyzed, the eye would bulge forward from loss of control. So if one muscle is paralyzed, the eye falls away from the direction of the lost muscle control. (2) Secondary: If the good eye be covered, and the defective eye be made to fix an object, the nerve impulse to attempt this is so great that the corresponding muscle of the good eye gets too much stimulus, does double work, and deviates.

Subjective Tests (IV., V., and VI.):

IV. With diplopia there is frequently *giddiness* in walking. It is relieved when the affected eye is covered up, but it becomes more marked if the patient cover his sound eye. The smaller the degree of squint, the more troublesome is the diplopia; for the image in a slightly deviating eye is formed near to the macula, and hence is much more distinct than one formed in the periphery of the retina, as in high degrees of squint.

V. *False Projection.*—We judge the position of objects by the nerve power required to turn the eye to that object. In paralysis there are extra impulses to attempt to keep the eye straight; so our judgment of the position of the object is vitiated. Hold up a pencil in the place where the patient sees double; cover the good eye; tell the patient to touch the pencil quickly. He fails, and points beyond the pencil.

VI. *Mapping out the Diplopia.*—First let the student perform a couple of simple experiments with his own eyes.

1. Fix both eyes on a distant object—say, a chimney; hold up a finger at arm's length before the eyes: it will appear double. By rapidly shutting right or left eye the student will

find that of the two images of the finger, the left is seen by the right and the right by the left eye—*i.e.*, there is **crossed diplopia.** This occurred when the eyes were looking far away, when the internal muscles were out of action; hence crossed diplopia may be looked for with paralysis of muscles that turn the eyes **in.**

2. Fix both eyes on the finger held up at arm's length; the distant object will appear double. By rapidly shutting right or left eye the student will find the right eye sees the right image, and the left eye the left image—*i.e.*, there is **homonymous diplopia.** This occurred in near vision, when the external muscles were out of action; hence homonymous diplopia may be looked for in paralysis of muscles that turn the eyes **out.**

The experiments may be made very striking by putting red glass before the right eye and green before the left, and using lighted candles for the objects.

Having seen the diplopia for himself, the student may proceed to test his patient. Fix the patient's head; put on him spectacles glazed with light-coloured glass—right side red, left side green. Pass a lighted candle before him from side to side, at the level of his eyes, above, and below this level. Let him look at and follow the candle, and state how he sees the candle image or images in all of these nine positions. Mark the images on a chart like this:

L. The patient looks— R.

Up and to left.	Up.	Up and to right.
To left.	Straight ahead.	To right.
Down and to left.	Down.	Down and to right.

To diagnose the paralysis producing the diplopia marked out on such a chart, consider . . .—

1. The **false image**, or the image that lies farthest in the region of greatest diplopia, it **belongs to the paralyzed eye.**

2. Is the diplopia **crossed or homonymous**?—*i.e.*, failure of a muscle turning the eye **IN** or **OUT**.

3. Where is the **maximum** diplopia?

(*a*) *Vertically.*—Is it above or below horizontal?—*i.e.*, failure of a muscle turning the eye **UP** or **DOWN**.

(*b*) *Laterally.*—Is it to right or left side?—*i.e.*, failure of a muscle turning the eye to **R** or **L**.

These three tests are almost always sufficient to establish the diagnosis, but another confirmatory test may be used.

4. Is one of the images tilted constantly into the line of a muscle rotating the eye **IN** or **OUT**?

PATIENT'S VIEW.

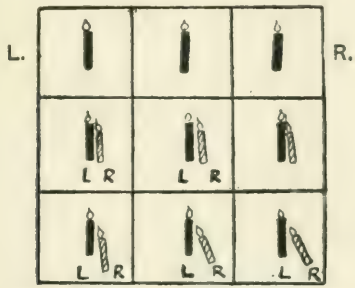


FIG. 71.—Chart of diplopia in paralysis of right superior oblique (Example II.).

A young man fell from a scaffold. After the immediate effects of the fall had been recovered from, diplopia persisted. He could not walk upstairs with both eyes open, for the steps were seen double.

EXAMPLE 1.—1. False image (lying farthest in the region of greatest diplopia) belongs to the **R.** eye *i.e.*, paresis of a right eye muscle.

2. Diplopia is homonymous = **OUT**-turning muscle (external rectus, superior or inferior obliques).

3. Lateral diplopia only and to **R.** = right external rectus. Abscence of vertical displacement, or constant tilt, confirms diagnosis.

EXAMPLE II.—Fig. 71. 1. False image belongs to the **R.** eye.

2. Diplopia is homonymous = **OUT**-turning muscle.

3. (*a*) Diplopia most marked *below* horizontal = superior oblique. (*b*) Some lateral displacement, and most to extreme **R.** = right superior oblique.

4. One image constantly leans towards the nose; confirms diagnosis (see Fig. 71).

PATIENT'S VIEW.

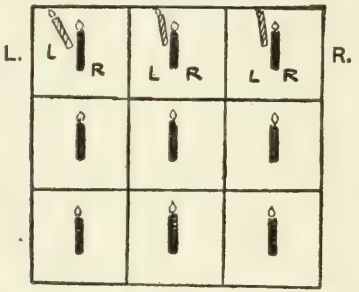


FIG. 72.—Chart of diplopia in paralysis of left inferior oblique (Example IV.).

A man was thrown violently on to his head. After the immediate effects were recovered from, diplopia persisted. He used to part his hair on the left side; now he cannot see to do this with both eyes open.

EXAMPLE III.—1. False image belongs to **L.** eye.

2. Diplopia is crossed = **IN**-turning muscle (internal, superior, or inferior recti).

3. Diplopia is lateral only and to **R.** = left internal rectus.

EXAMPLE IV.—Fig. 72. 1. False image belongs to **L.** eye.

2. Diplopia is homonymous (see Example I.).

3 (*a*) Diplopia worst *above* horizontal = inferior oblique (*b*) Some lateral diplopia, and most to extreme **L.** = left inferior oblique.

4. Note tilt of false image.

The Diagram of Muscle Actions (Fig. 70).—This will serve two other uses :

1. Since the greatest diplopia lies in the direction of the action of the paralyzed muscle, the arrow points to the region of greatest diplopia.

2. It can be used to show the relative positions of the true and false images in single muscle paralysis. Place a match vertically on each diagram of the figure. The match will represent the true image, and the four corner rays, marked **Sup. R.**, **Inf. R.**, **Sup. O.**, and **Inf. O.**, will represent the relative positions (in vertical and lateral displacement and tilt) of the false image produced in paralysis of each of these muscles. In paralysis of internal or external rectus, the false image would lie vertically through their respective arrow-heads.

Frequency of Paralysis.—As a rule, paralysis of the oculomotor system is not complete, but affects one or two muscles or one nerve. Paralysis of the external rectus (sixth nerve) is most common ; next, that of the superior oblique (fourth nerve). If the whole of the third nerve be paralyzed, the following symptoms are present : The upper eyelid droops. The globe can only be turned outwards, and very slightly downwards with rotation inwards of the vertical meridian. The power of accommodation is lost and the pupil is somewhat dilated, and does not contract to stimulation by light of either eye.

Ætiology of Paralysis.—Paralysis of one or more ocular muscles (including the levator palpebræ) may be—(1) a symptom of locomotor ataxia or tabes dorsalis ; (2) due to syphilitic disease of the corresponding nerve trunk or nucleus ; (3) a symptom of meningitis ; (4) a result of injury to the orbit or to the skull (fractured base), etc. ; (5) associated with tumour or hæmorrhage at the base of the brain ; (6) exposure to cold ; (7) post-diphtheritic.

In total ophthalmoplegia : If one-sided, the cause is probably

about the cavernous sinus—*e.g.*, carotid aneurism or tumour—for all the oculo-motor nerves are grouped near each other on the wall of the sinus. If on both sides, it is probably due to inflammation and degeneration of the nerve origins in the floor of the aqueduct of Sylvius. In either case syphilis is frequently the origin of the disease, and more or less complete recovery may follow early and resolute treatment.

Treatment.—If a diathesis—*e.g.*, syphilis—be the prime cause, treat that; these cases may recover. If caused by injury, treatment is of no avail. In peripheral neuritis, hot baths, diaphoresis, and strychnine are of use. The paralyzed muscle should be exercised by electricity pending the effect of treatment. In hopeless cases prisms or operation to restore the balance may be utilized.

Nystagmus.—Involuntary jerky oscillations of the eyeballs; usually lateral or rotary, sometimes vertical, the to and fro movements are equally rapid. The patients are usually unconscious of the movement; it ceases during sleep. It is congenital in albinism, extreme astigmatism, and some other anomalies. It is acquired after ophthalmia neonatorum, when the eyes are badly damaged. In adults it appears in brain disease, especially disseminated sclerosis. 'Miner's nystagmus' follows fatigue of the eye muscles, caused by constant working in awkward postures.

Vestibular Nystagmus can be produced by (1) rotating the patient on a turntable, (2) syringing the ear, with hot or cold water, (3) stimulation of the labyrinth. The movements differ from those of ordinary nystagmus; the deviation is slow and the return rapid.

Ptosis Palpebræ (Drooping of the Upper Lid).—Due to paralysis or defect of the levator palpebræ superioris. It may be partial or complete. When complete the globe is covered, and vision by that eye is impossible, unless the head be thrown well back. The eyebrow is raised in an attempt by the frontalis muscle to lift the lid. Ptosis may be acquired or congenital.

1. *Acquired.*—When the result of lesion of the third nucleus, it is associated with paralysis of other of the third nerve

muscles. In cerebro-spinal disease (*e.g.*, tabes dorsalis) it may occur alone.

2. *Sympathetic.*—Paralysis of the sympathetic cord or its branches is followed by loss of action of the unstriped muscle fibres that help lift the lid. The striped fibres of the Levator remain active (p. 152).

3. *Congenital.*—The levator palpebræ is developed by splitting off from the rectus superior; it may be absent or weakly developed. The defect may be remedied by operation (p. 179).

4. *Functional.*—Hysterical ptosis (p. 163) is occasionally seen in women. Partial ptosis occurs in myasthenia gravis (p. 162) and varies with the state of the patient. In neither condition is there over-action of the frontalis in an attempt to lift the lid. Slight ptosis is seen also in trachoma, a state instantly determined by everting the lid.

Jaw-winking Movements (*Synkinesis*).—In some cases of partial unilateral congenital ptosis, the ptosis disappears when the jaw muscles are put into action, so that in eating the lid jerks up and down. This is an atavism—*i.e.*, a reversion to a primitive or ancestral condition. The facial muscles are derived from the muscles of the spiracle (first gill, now ear-tube). In their primitive state there is rhythmic association betwixt jaw and spiracle movements for breathing; this can be seen in any fish. Jaw-winking tends to disappear at adult age.

Hemiplegia.—In paralysis of one side of the body from cortical lesion the eye muscles are not paralyzed. This is due to crossed innervation from both hemispheres effecting control of bilateral nuclei, which usually or always act in concert, so that when one hemisphere is out of action the other does double duty.

The same explanation covers the case of the orbicularis palpebrarum, frontalis, and corrugator supercilii muscles, which usually act in concert bilaterally, and so escape paralysis, although some weakness on the hemiplegic side may frequently be found.

Because of the escape of these upper facial muscles, Mendel put forward the hypothesis that they were really eye muscles

innervated primarily by the third nucleus ; and as a corollary the orbicularis oris was cut off from the seventh nucleus and attached to the twelfth, because it alone of all the facial muscles is affected in progressive bulbar paralysis. There is no good ground for this hypothesis ; on the contrary, the facial musculature is a unity, derived from the musculature of the spiracle, which in all conditions is innervated from the seventh nucleus, a nucleus of a class that Gaskell calls 'visceral,' and distinct from the 'somatic' class, to which the third and twelfth nuclei belong.

Myasthenia Gravis.—Double ptosis, defect of ocular movements and diplopia are common and early symptoms. The pupils contract to light, but quickly dilate again. The muscles of the limbs, jaw, and head are frequently affected, and the droop of the head is characteristic. All the paralyses are variable, sometimes a movement is good, then it fails after a little exercise. Women are more commonly affected.

Graves's Disease.—The ocular symptoms form a distinct group. 1. Stellwag's sign—protrusion of eyes or retraction of upper lid. 2. Graefe's sign—lagging of upper lid on looking down. 3. Kocher's sign—lagging of the lower on looking up. 4. Mobius's sign—diplopia in near work in extreme protrusion of eyes. 5. Landstrom's sign—sudden retraction of lids when fixing the eyes upon a near-point. (1, 2, and 3, are the most common.)

XXXII. AMBLYOPIA, RETINAL AND CEREBRAL.

Congenital Amblyopia.—When affecting both eyes it is usually associated with microphthalmia, high errors of refraction, or some defect such as albinism. The inference is that when images cannot be focussed the macula does not develop normal receptive acuity. There is usually nystagmus. After extraction of some congenital cataracts this condition is found ; such children are often mentally defective.

Amblyopia ex Anopsia.—The result of disuse from infancy —*e.g.*, in squint the vision of the squinting eye is suppressed

(see 'Squint,' p. 144). This does not occur once the vision of an eye is thoroughly established.

Monocular Lid-Wink is a useful sign of long standing amblyopia—'Bean pods are noisiest when dry, and you always wink with your weakest eye.'—Bret Harte.

Hysterical Amblyopia.—Usually of one eye, and in girls. More or less suppression of vision, or greatly contracted fields. On each succeeding test the field may be smaller. The relation of the colour fields to each other may be altered. There is occasionally partial ptosis of one lid. Pupil reflexes and fundus are normal.

Treatment.—Control by healthy-minded guardians; tonics, and electric battery.

Malingering.—Blindness may be shammed to obtain compensation for injury by workmen, or discharge by soldiers, or sympathy by hysterical girls. Usually only one eye is affected, rarely both.

Tests.—1. Try the pupil reactions (p. 6). Test the refraction by retinoscopy and carefully examine the fundus of each eye.

2. Begin to test the distant vision with both eyes open, and slip a + 6 D cylinder axis vertical before the good eye, and a +0·25 D cylinder axis before the blind eye. If reading is continued, it is the 'blind' eye that reads.

3. Diaphragm Test (p. 148). If unequal refraction be shown by retinoscopy put up suitable glasses. Use a simple picture card or a line of letters. Watch the man's eyes intently. If he sees with both eyes the *co-ordinate movement of the eyes*, as first one and then the other part of the test card are looked at, will give the answer without any word from the man. If he be blind in one eye there will be no such movement, for there will be only one object to see. The test card is seen by crossed vision and should be correctly named by the seeing eye.

4. Cover the 'blind' eye. Place before the good eye a 6° prism apex up, and just on a line with the centre of the pupil, so as to cause monocular diplopia. Now at the same moment, uncover the 'blind' eye and push the prism up to cover the other eye. If diplopia persists both eyes see.

5. Get a transparent test card with red and green letters; put on spectacles glazed red in one eye, green in the other. If the man reads all the letters, both eyes see (see Colour Vision).

The student should try these tests on himself. In examining a patient watch must be kept that he does not shut one eye.

In suspected shammed total blindness carefully examine the eyes and the body to determine absence of other symptoms. Then have the patient watched. A suspected lad in a blind school was caught out by watching his movements in the playground. Later, after juggling with big lenses, he read $\frac{9}{6}$, though he declared he could see nothing naked-eyed.

Shamming Deficient Vision.—In examination for State purposes, *e.g.*, Military Service, men occasionally pretend to worse vision than the state of their eyes warrant. Detection is difficult. The examiner must first be assured of the state of the eyes, then by repeated shifting of the lenses attempt to inveigle the man into an inconsistency. Finally, a test devised by the author will be of service. Take two Snellen's types. Paste one, ranging from $\frac{6}{60}$ to $\frac{9}{9}$ on one side of a board. Alter the other to range from $\frac{6}{36}$ to $\frac{6}{6}$ arranged to match pattern of No. 1. Paste the altered No. 2 test on the other side of the board. Expose No. 1 test. Say the man reads three lines, Vision $= \frac{6}{24}$. Now expose No. 2 test, if the man reads three lines again his vision now $= \frac{6}{12}$, and he is convicted of inconsistency and suspect of shamming deficiency.

Congenital Colour Blindness.—Daltonism, so named because Dalton the scientist, himself colour-blind, first described it. Occurs in 3 to 4 per cent. of males, and is sometimes hereditary. The eyes and intelligence are otherwise normal. It may be likened to tone deafness, which is also hereditary in some highly intellectual families. The defect is serious in seamen and railwaymen. The sense of red-green is most commonly absent. These colours appear of equally greyish hue. Light and shade perception is not altered.

Theories of Colour Vision.—1. The *Young-Helmholtz* theory

is anatomical. It supposes the rods and cones of the retina are in three sets to detect red, green, and violet—the primary colours. That this is not true is shown by projecting a minute beam of light on the retina; the smallest detectable light has no colour, it is white.

2. *Hering's* theory is based on the experience of after-effects. After watching a red light one sees a green after-effect. It supposes three different visual substances in the retina; white-black, red green, and blue yellow. Light acts chemically on these substances, building up or exhausting them, so conveying sensation to the brain.

3. *Edridge Green's* theory is cerebral, and based on observations of the values of colour sensibility. It supposes the visual purple in the retina is altered by light, just as is the photographic plate in a camera. These chemical changes stimulate the brain, which learns to associate variations of stimulation with variations of light.

Edridge Green shows there are two kinds of colour blindness:

1. Loss of a colour—*e.g.*, a red blind man will not see light in a room, the window of which is glazed with pure spectrum red glass (Try looking at a red window through pure green glass. Refer also to Test 4 for malingering.)

2. Partial loss of a colour—*e.g.*, red can be seen, but the whole of the red in the spectrum cannot be distinguished. A man so affected will fail to detect a red light in the far distance, or when partly obscured by fog. This is of great importance.

Tests for Colour Vision.—Red and green are the signal lights, so are of the greatest importance.

1 Holmgren's is 'official.' Numerous coloured wools of all shades are classed: (1) Test colours: pale green, light pink, and bright red. (2) Match colours: other shades of these same colours. (3) Confusion colours: yellow, brown, fawn, mauve, etc., which experience has shown the colour-blind select as matches by mistake. The man has merely to *match* colours, and not to name them. It is quite easy for an educated person, though colour-blind, to pass the test.

2. Edridge Green uses four test colours — orange, violet, blue-green, red — in a lantern, or else in wools. The man has to *name* the colour, and match it with others. The test is infallible.

Acquired Colour Blindness.—A symptom of disease of retina or optic nerve (see Tobacco Blindness, p. 93).

Coloured Vision.—Optic hallucination; cause unknown. Red (erythropsia) is not uncommonly seen after cataract extraction, but other colours are complained of.

Toxic Amblyopia.—Usually due to drugs—*e.g.*, tobacco. Quinine has a serious effect in large doses: there is sudden blindness, loss of fields, dilated pupils, pale discs, and spasm of the retinal arteries.

Treatment.—Stop the drug, give injections of strychnine and inhalations of amyl nitrite.

Eclipse Blindness.—Central scotoma, or dark spot in the centre of the field of vision, may follow naked-eye examination of a sun eclipse or looking at the sun. Occasionally changes have been seen at the macula of the eye—either a pale yellow spot or darkening of pigment. Slight cases recover speedily; when the scotoma is large, some defect may persist.

Treatment.—Rest and dark glasses.

Snow and Electric-light Blindness.—Somewhat similar results follow undue exposure to the intense glare of sunlight on snow or the electric arc. There is some conjunctivitis and swelling of the lids, followed by a more or less persistent central scotoma. Prevention should be secured by wearing amber-tinted glasses, which cut off the actinic rays.

Word Blindness.—A rare condition, in which, although characters can be seen, their meaning cannot be determined. It is sometimes found in school-children; in some cases it is not possible to teach them to read, although figures and money may be intelligible to them. It is a cerebral defect, and akin to colour blindness and tone deafness.

Night Blindness.—Due to deficiency in sensibility of the periphery of the retina. Retinitis pigmentosa is the most

serious cause (p. 94). It occurs in xerosis of the conjunctiva (p. 37), but here no retinal change may be found. Mechanically the field may be reduced by opacities in the periphery of the lens, and make walking difficult at night.

Treatment.—Tonics.

Day Blindness.—When there is a central scotoma—*e.g.*, in tobacco amblyopia—the spot is recognized, and causes annoyance in a bright light; further, in such cases the retina is more easily fatigued by light than in health.

XXXIII. HEMIANOPSIA.

We may divide the paths of the optic fibres into seven parts from retina to cortex. The diagram (p. 168) shows broadly how the fibres are arranged:

Retina.
Optic nerve.
Optic chiasm.
Optic tract.
Optic ganglia (corpora geniculata et quadrigemina).
Optic radiation in the hemisphere.
Occipital cortex.

Disease or injury may affect any of these parts, and vision will suffer accordingly.

The ganglia cut these parts into two groups: (1) peripheral, including retina, nerve, chiasm, and tract; and (2) central, including optic radiation and cortex. The pupil phenomena vary as the lesion is peripheral or central. The optic ganglia translate stimuli into impulses along the posterior longitudinal bundle (P.L.B.) to the motor oculi nuclei (see diagram). A central lesion leaves this connection untouched; a peripheral lesion cuts it off in whole or in part.

Sites of Lesions.—The diagram has on the left side and middle line five circles; these represent five lesions

Lesion 1. Of the **optic nerve.** Causes complete blindness of one eye, loss of pupil reaction to light, but not to consensual

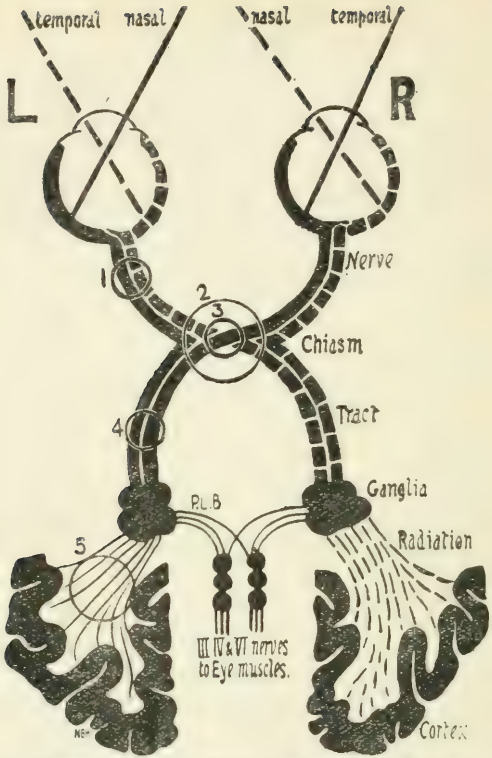


FIG. 73.—Diagram to show paths of light stimuli to the brain. The field retinæ, tracts and brain connections of the two eyes are in two halves. In the nerve sections these halves will be called *dextral* and *sinistral*. The dextral connections are marked in broken line, the sinistral in solid line throughout.

I. **Fields.**—Nasal half of one eye overlaps temporal half of other.

II. **Projection.**—The left nasal field is seen by the left sinistral retina, and the right temporal field by the right sinistral retina. These are corresponding parts of the two retinæ. From the retinæ the nerve fibres arise.

III. **Chiasm.**—Here the fibres from corresponding retinal halves unite: the right and left *sinistral* to form the *left* optic tract, and the right and left *dextral* to form the *right* optic tract. The tracts pass through the ganglia to reach the left and right hemispheres respectively.

The macula of each eye is supplied by *both* halves. Note the overlapping to indicate this, and compare fields in Fig. 74.

stimulation (p. 6); there are usually changes in the disc indicating optic neuritis.

Lesion 2. Of the **whole of the chiasm**—*e.g.*, large tumour of pituitary body. Causes blindness of both eyes, loss of all pupil reactions, and usually changes in the disc.

Lesion 3. Of **median part of the chiasm**, involving the crossing fibres—*e.g.*, small tumour of pituitary body. Causes bitemporal hemianopsia. Both temporal halves of fields are lost, because the right sinistral and left dextral halves of the retinæ are blind. Light thrown on these halves of the retinæ

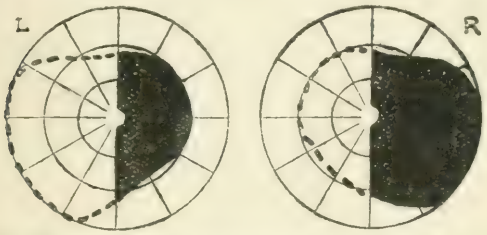


FIG. 74.—Fields in right homonymous hemianopsia, caused by lesions of the left optic tract, ganglia, radiation, or cortex.

Note the integrity of the macular circle by reason of its connection with both halves of the brain.

causes no pupil reaction, but thrown on the other halves the pupils contract (Wernicke's hemianoptic pupil reaction). There are usually changes in the discs.

Lesion 4. Of the **optic tract**—*e.g.*, gumma or tumour beneath mid-brain. Causes right homonymous hemianopsia—*i.e.*, loss of right half of field of each eye (see Fig. 74)—because the sinistral halves of the retina of each eye are blind. Light thrown on these parts causes no pupil reaction. The discs frequently show no change. This is the commonest variety of hemianopsia. Lesions of the **ganglia** cause similar symptoms.

Lesion 5. Of the **optic radiation**—the fibres of Gratiolet. Causes the same hemianopsia as No. 4; but the pupil reactions are not affected, for the lower plane of connections through the ganglia is clear. Changes at the discs are rare when the white matter alone is affected.

Lesions of the **occipital cortex** cause the same hemianopsia as No. 4, but the pupil reactions are not affected. Growths affecting the vascular grey matter of the cortex are very likely to be associated with optic neuritis.

Migraine.—A form of sick headache, in which there is temporary hemianopsia, with zigzag light sensations, sometimes preceded by tingling of the fingers, and rarely succeeded by slight aphasia. After the aura there is violent one-sided headache and perhaps sickness.

It may be hereditary, and is frequent amongst neurotic and highly cultured folk. It is probably caused by a cortical vascular disturbance, set up by some irritation.

Treatment.—Correct any error of refraction; improve the general health.

XXXIV. OCULAR THERAPEUTICS.

Under each disease noticed in the foregoing pages the treatment appropriate to the condition has been indicated. In this chapter it is not proposed to repeat those indications, but to suggest to the student the manner in which he should approach the treatment of any given case.

The eye is a member of the body; if it suffer hurt the whole body may suffer with it; or the eye may suffer because as a member of an affected body it is involved in the general hurt. Given trouble with the eye, to succeed in correcting that trouble we must be able to distinguish between these two conditions: a local eye trouble, and a general diathesis affecting the eye. The eye is red, watery, and light hurts it. Is the condition merely a conjunctivitis, or is it an iritis? If the first, local treatment is all that is needed; if the second,

appropriate local treatment will be insufficient, the general condition that has given rise to the iritis must be found and attacked.

In prescribing part of the difficulty met by students is the number of drugs from which choice has to be made. Take for example *collyria*. There are a host of lotions, all are of mild degree, powerful drugs are in solution, but in minute quantities. From boric acid to corrosive sublimate is a wide stretch, suggesting an intervening gradation both flexible and valuable. But, with rare exceptions, it seems that in the strength in which alone we can safely use them as lotions all are of equal efficiency as germicides.

In general, any solution of different specific gravity to the tears will excite a flow of tears, and by promoting this natural irrigation wash the eye free from foreign bodies whether minute and microbic or gross and earthy.

Certain indications are to be obtained from the characters of the disease. The differences in blepharo-conjunctivitis, angular, and muco-purulent conjunctivitis, illustrate this. The first is mostly due to pyogenic organisms, crusting and pustular eruptions mark the lids; antiseptic lotions and ointments cannot penetrate these crusts, some cleansing lotion is the first necessity, and we find this in the alkaline bicarbonate of soda which will turn the greasy glandular secretion into soap. In angular conjunctivitis due to the Morax-Axenfeld bacillus the inflammation is superficial, the marked feature is the sodden skin at the angles of the lids; an astringent is indicated, we find it in zinc sulphate, which has proved a specific In muco-purulent conjunctivitis due to the Koch-Weeks bacillus the frequent relapses suggest that the organism lurks in the folds and crypts of the mucous membrane, so we seek a drug of penetrating power, and get it in a weak solution of zinc chloride.

Or again, a patient suffers recurrent conjunctivitis of one eye of no particular character; we find no organisms in the discharge, save the ubiquitous xerosis bacillus. The possibility of a fifth nerve irritation should be investigated; there may be an error of refraction, or nasal trouble, and the patient may be

using strong nasal douches, or the teeth may be bad. It is evident that in such a case no local conjunctival treatment would avail.

The use of solutions of *silver* as pigments in acute conjunctivitis is an established procedure, but the form of the silver preparation will merit attention. The choice is between silver nitrate and a host of colloidal silvers, such as protargol, argyrol, collargol, etc. The student should refer to the research of the Therapeutic Committee of the British Medical Association (*B.M.J.*, 1906, ii., p. 359) on the Bactericidal Action of Silver Compounds. He might then try, in the manner suggested in the last paragraph of this chapter, the comparative effects of some of these costly proprietary preparations, and of the inexpensive and time-proven solutions of the nitrate. Let him try the nitrate in less than usual strength, say $\frac{1}{2}$ or even $\frac{1}{4}$ per cent., and note how the addition of 10 to 15 per cent. of glycerine enhances the effect and reduces the sting of these nitrate solutions.

The possibility of exercising a nice discrimination in treatment depends upon an exact knowledge of the cause of the disease, and in such local conditions as conjunctivitis we can only get this by taking pains to examine the discharges in approved bacteriological fashion.

The *vehicle* in which a drug is administered may materially affect its utility. A large number of alkaloids are in use ; some are costly and need economical handling, others must be used daily for long periods, and difficulty arises in keeping them fresh and unirritating. Oily solutions of these alkaloids may with advantage be substituted for the common watery ones. The costly homatropine goes much farther and acts better in oily solution ; eserine in oil may be used for long periods without setting up the follicular conjunctivitis so annoyingly frequent with watery solutions. Similarly, differences will be found in the use of ointment and water vehicles, as in the use of atropine ; in most cases the ointment has the advantage.

As a *preservative* of watery solutions of alkaloids,—*e.g.*,

cocaine for operations—the following can be strongly recommended :

Tincture of iodine 2 minims,
Oil of gaultheria 2 minims,
Menthol 2 grains,
Water 1 pint.

Put up in stoppered bottle, use as a stock solvent.

The usage of *physical agents*, heat, cold, electricity, and massage, require as much if not more thought and care for their successful handling than do drugs. The relative values of ordinary degrees of heat and cold in the reduction of inflammation and the promotion of healing is constantly discussed. Recent experiments upon the healing of artificially produced corneal wounds were conclusive in the complete superiority of heat over cold, and over all sorts of drugs such as cocaine, corrosive sublimate, and dionine.

In their more intense forms steam has been used as a means of producing hyperæmia and a healthy reaction in trachoma and other such chronic diseases ; but in this disease extreme cold in the form of solid carbon dioxide snow bids fair to oust not only heat, but all forms of electricity, and perhaps even drugs. Whilst in the treatment of those common excrescences of the lids, nævi, papillomata, and rodent ulcers, the snow has already shown its superiority to X-rays, high frequency currents, ionization, and even radium.

The *cautery* (p. 55) is a valuable physical agent when used with discretion. The actual or galvano-cautery is serviceable in destroying dangerously infected tissue, as in sloughing ulcers. The application of concentrated drugs is more common ; absolute alcohol, pure carbolic, strong perchloride of mercury solutions are used. My preference is for phenocamphor, a fluid formed by adding together equal parts of camphor and carbolic crystals. The fluid is at once a penetrating antiseptic and anæsthetic, whilst the tissue recovers from the effects of the application with less permanent injury than after any other form of cautery whether heat or drug.

The modification of the *circulation* of an inflamed part —*e.g.*, in iritis—will exert great influence in the reduction of pain, and in promoting resolution. For this purpose we use such purely physical agents as leeches to deplete the vessels, fomentations to relax their walls and the pressure of the tissues, or drugs such as dionine, which is at once a vaso-dilator, lymphogogue, and anodyne.

Subconjunctival injections, of plain water, saline solution, chloride or cyanide of mercury, have been used with the intent of securing more profound and metabolic changes than surface applications can afford in refractory diseases as choroiditis, detached retina, and the like. Results have been very variable in different hands, which is perhaps not remarkable considering the intractable nature of the conditions for which these remedies have been used.

Massage is a simple mode of securing good results in old disorders, such as scars of the cornea. The instillation of a slightly stimulating ointment—*e.g.*, yellow oxide of mercury—followed by the gentle circular movement of the upper lid over the cornea, is more successful than the use of fibrolysin or other derivatives of mustard, but the massage takes time and patience.

Bacterial products open up vast possibilities for careful work. Of antitoxins only one has established itself, that of diphtheria. In vaccines genuine utility has been shown for some, notably tuberculin and those of the coccal order—staphylococcus, streptococcus, and gonococcus. The use of these forms of medication is in such a state of flux and is necessarily so closely associated with the laboratory that the student should seek there for guidance in selection and dosage.

The *internal administration* of medicants for ocular and general diatheses, such as syphilis, rheumatism, and gout, will always entail thought, to obtain the best results with the least discomfort to the patient. The severity or otherwise of the ocular symptom that calls attention to a general diathesis may influence our choice of general treatment, but in the main it should follow the lines of general therapeutics, and be regulated by the necessity and peculiarity of each patient.

Consider, for example, the general treatment in ocular manifestations of syphilis. For interstitial keratitis of inherited origin in a young child salvarsan is not so successful as mercurials, but it is a brilliant success in the keratitis of acquired syphilis in an adult. For acute iritis in a young man salvarsan should be used notwithstanding that simpler treatment will suffice to check the immediate manifestation. For severe cyclitis, with vitreous opacities, or optic neuritis in secondary syphilis, both salvarsan and mercurials should be pressed; but for optic neuritis, due to cerebral gumma or meningitis, salvarsan is less useful than iodides—pending a decompression operation.

In eye as in general treatment it is well to know the powers of a few drugs and to use these discriminately rather than to run haphazard through a whole armoury of unproved weapons. New drugs or new preparations of old drugs will call for attention and must be tried; and in local ocular treatment there is this great advantage, we can use the new for one eye and the old for the other and gain fair comparative observations.

XXXV. OPERATIONS.

(*Certain minor operations are described in earlier chapters. See Index.*)

Scrupulous cleanliness or asepsis must be observed in the performance of any operation on the eye. It is the more important since strong antiseptic lotions cannot be used owing to their irritant effect, and because of the very general presence of germs in the healthy conjunctival sac, and the direct continuity of this sac with the lachrymal sac and nose.

No operation should be performed upon the eyeball unless the operator is satisfied of the health of the conjunctiva and of the lachrymal sac. Should an operation be urgent, he is justified in eliminating the lachrymal sac as a source of infection by sealing the puncta with the cautery, by laying open and draining the sac, or by excising it altogether.

The operator's hands must be scrupulously cleansed by

repeated scrubbing with soft soap, and subsequent immersion in a solution of corrosive sublimate (1 in 2,000). No solution should be used that numbs the sensibility of the fingers.

All instruments to be used should be boiled in water for five minutes, and removed thence into warm boracic lotion. Knives should be placed in absolute alcohol after boiling until the moment they are required; then they should be washed in boracic.

Swabs.—For eye operations the ordinary surgical swabs are useless. Pieces of fine lint $1\frac{1}{2} \times 1$ inches, well boiled, and rung out in a cloth are requisite.

The skin of the lids and lashes should be cleansed with ether-soap six hours before the operation, and then covered with a boracic fomentation. Immediately before the operation thoroughly irrigate the conjunctiva, particularly the region of the caruncle, with boracic or saline solution.

Anæsthesia.—For most operations on the eyeball, instillation of a 5 per cent. solution of freshly prepared and sterile cocaine is sufficient. The anæsthesia affects the conjunctiva and cornea, but not the iris; it is complete in two or three minutes, and lasts ten minutes. For intraocular and squint operation, it is well to repeat the instillation every two minutes for ten minutes before operating. Some surgeons advocate sub-conjunctival injections of the anæsthetic.

General anæthesia is necessary for enucleation, for some glaucoma operations, and in children.

Adrenalin.—A solution of 1 in 1,000 is of great service in checking hæmorrhage in many eye operations. It may be combined with the cocaine solution. It must be remembered that symptoms of glaucoma have sometimes followed its use in middle-aged and predisposed subjects.

Ambidexterity.—The surgeon will need to be ambidextrous to perform all the necessary operations on the globe, such as to incise the cornea with a Graefe knife held in right or left hand, as the case may need. This facility is easily obtained with a little practice.

Practice on globe operations may be made with pig's or

sheep's eyes. Pig's eyes are nearly the same size as human, but are too tough ; sheep's eyes are large, but more nearly of human texture. A convenient phantom in which to secure the eye may be made as follows : Take a cardboard box $4 \times 2 \times 2$ inches ; cut a piece of bar yellow soap to fit inside ; scoop out a cavity from one side of the soap just large enough to take an eye, yet leave the cornea standing well out ; cut a hole in the lid of the box just a little larger than the cornea, to correspond with the cavity in the soap ; put the lid on and secure with elastic bands. The eye in its soapy bed slips about as readily as it does in life even under an anæsthetic.

Operations on the Lids.

Trichiasis.—Excision or ablation of the edge of the lid with the lashes should never be performed ; the hard linear scar frequently becomes turned in on the globe, and rasps the

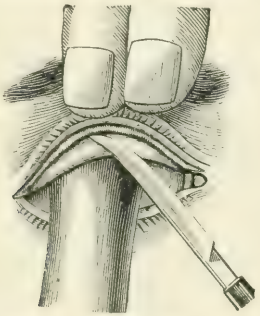


Fig. 75.—Operation for Entropion—splitting the lid.

cornea more than a row of lashes. If only one or two lashes are at fault they may be destroyed by electrolysis.

Transplantation of Hair Follicles (for Trichiasis and Entropion) of the Upper Lid.—Jaesche-Arlt's method is the most satisfactory. Fix the lid in a clamp ; with a sharp thin knife cut into the intermarginal space betwixt the lashes and the

mouths of the Meibomian glands to a depth of 5 millimetres, so as to split the lid into two layers, the outer carrying the lashes. Now incise the skin of the lid from side to side, parallel to and 5 millimetres from its margin, and again in an arch bending upwards 5 millimetres. The two incisions must cut skin only, and meet at their extremities. The crescentic piece of skin these incisions bound is removed, and the outer layer of the split lid, carrying the lashes, is pushed up and sutured in its place. The raw margin may be left to granulate over.

Entropion of the Lower Lid.—Excision of skin and muscle. Fix the lid in a clamp, excise a strip of skin by two horizontal incisions, meeting at each end; lift up the exposed muscle, and excise that. Close the wound with deep sutures, securing skin and deep tissues together. Seal with flexile collodion.

Ectropion.—(1) When due to slackness of the tissues Snellen's suture is most effective. A stout silk thread is armed with a curved needle at each end. Insert the needles about 5 millimetres from each other into the bulging conjunctiva; bring both out through the skin of the lid level with the orbital margin, and about 10 millimetres apart. Draw the thread tight, so as to turn the lid in; tie the sutures over a piece of drainage-tube, and dust with boracic powder. Remove after a week. The thread causes irritation and the growth of scar tissue in its track: the more irritation the better the result.

(2) When due to chronic conjunctivitis: (*a*) The marginal strip of the diseased conjunctiva may be excised, and the wound closed by sutures. (*b*) A row of punctures may be made on the exposed conjunctiva with the actual cautery: the scars contract and turn in the lid.

(3) When due to scars of the skin, the V-Y operation is best. Make a V-shaped incision mouth upwards to embrace the scar, loosen the tongue of tissue from its bed, push it upwards to bring the edge of the lid in line. The wound will now appear Y-shaped; stitch up in this position. Bands of scar tissue, binding upper or lower lid to the subjacent bones, should be freely divided subcutaneously with a tenotomy knife.

Epicanthus.—Some surgeons excise an oval piece of skin vertically from the bridge of the nose. It is better to put the tight epicanthal band on the stretch from above downwards, cut the band across horizontally, and by continued tension convert the horizontal button-hole into a vertical one, then close the wound in this position.

Ptosis Palpebræ.—Two operations of the many described are very effective. Each attempts to attach the lid to the frontalis muscle.

1. *Panas's Skin Operation.*—Midway between the brow and the lid margin make an incision shaped like a silk hat, with the brim downwards, and stretching to two-thirds the width of the lid; make a second incision just above the brow a little larger than the 'crown of the hat.' Insinuate the hat-shaped tongue of skin under the brow, bring it into the upper wound and suture to the upper lip thereof. The operation is useful, but if it fail the scars remain.

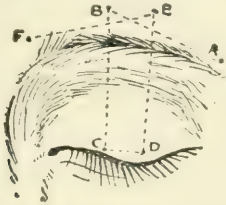


FIG. 76.—Harman's chain operation for ptosis palpebræ. The dotted lines indicate position for embedding the chain

2. The *chain operation* (Fig. 76) has had much success. By means of a silk thread, attach a length of No. 0 wove-chain, 15- or 18-carat gold, to a 4-inch straight needle with a triangular cutting point. By five stitches, AB, BC, and CD, and so on, bury the chain beneath the lid and brow. B and E must be situated at the point of greatest action of the frontalis muscle. Adjust the length of the loop at B and E, take up the slack at A and F, secure the ends to the skin, and seal the puncture

wounds with collodion. At the end of a week the excess chain at A and F may be cut off and the ends buried. Granulation tissue grows into the links of the chain, and makes a strong tendon from the frontalis to the lid.

It is important to bear in mind that no operation should be performed that fixes up the lid so that it does not cover the globe during sleep.

Partial Ptosis from weakness of the levator muscle may sometimes be remedied by advancing the muscle. Incise the skin at the upper margin of the tarsus, dissect out the muscle tendon, secure it in Prince's forceps, detach its insertion, and suture it to the surface of the tarsus lower down. The benefits are uncertain.

Motais' Transplantation of the Superior Rectus.—Depress the globe and secure with forceps, lift the upper lid. Expose the tendon of the superior rectus, then secure its middle third by passing in and out of the tendon a curved needle carrying a thread. Tie the suture, detach this tongue of tendon from the globe, and dissect up for 5 millimetres. Cut a tunnel from above the edge of the tarsus between the tarsus and skin to near the lashes ; pass the needle and thread along this track, and draw down the tongue of tendon ; tie the suture on the skin over a twist of lint just tight enough to hold the raw edge of the tongue of tendon and the tarsus in contact. The effect of the operation is to harness part of the rectus to the work of lifting the lid. Sometimes diplopia or entropion causes failure.

Operation on the Lachrymal Sac.

In chronic disease of the sac (p. 47) total excision may be necessary. A general anæsthetic is preferable, but local injections of cocaine and adrenalin may be used.

Instruments.—Scalpel, straight squint scissors, toothed clip forceps, special retractors, blunt dissector, sharp spoon, Weber's canaliculus knife, probe, cautery, sutures. Many swabs, several small clip forceps.

Position of Operator.—On the side of the patient to be operated upon.

Touch is much more satisfactory than sight in this tricky operation. Make sure of the site of the sac by (1) feeling the lachrymal groove in which it lies ; (2) slit up the lower canaliculus and pass in a stout probe with its end bent so that the knob can be turned forward and felt under the skin. Put the little finger tip over the sac so as to feel the bounds of the groove, make an incision 15 to 20 millimetres long through skin only along the finger to the nasal side, reflect the skin a little towards the canthus to expose the fascia. Cut the fascia in the same line and the tarsal ligament with it, and insert retractors to drag apart the lips of the wound and check bleeding. Now turn the probe head in the sac and feel it ; with a blunt dissector turn the sac out of its bed in the groove.

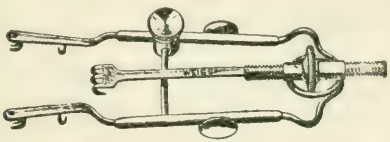


Fig. 77.—Harman's Retractors for Excision of Lachrymal Sac. (× ⅔.)

Seize it firmly with wide clip forceps. Continue the dissection upwards along its upper recess, where it is firmly adherent to the bone, and downward to the opening of the nasal duct. Pull the sac out until it is stretched, cut off close to bone above, duct below, and canthus outwards. Scrape out the bony nasal duct. Look to the canaliculi, slit up and destroy their mucosa by touching with a hot wire. Close and suture wound ; put on pressure pad and bandage. When the sac is removed, excess of tears gradually ceases, and there is no inconvenience except in cold winds.

Operations on the Eyeball.

Excision of the Globe (syn., Enucleation).—General anæsthesia is necessary.

Instruments.—Spring-stop speculum, fixation forceps, scissors curved on the flat, strabismus hook.

Position of Operator.—Behind the patient's head.

Introduce the speculum, and open it as wide as the orbit will allow ; fix it with the screw-stop. Pick up the conjunctiva with the forceps just above the cornea, cut it through, and then continue the division of the conjunctiva all round, keeping as close to the cornea as possible ; with a few snips of the scissors loosen the conjunctiva from the globe. Then open Tenon's capsule, pass the hook under one of the recti muscles, and divide it with the scissors ; repeat this with each rectus. Keep the hook and scissors close to the globe, and divide whatever is picked up by the former, whether it be a complete muscle insertion or a part of the fascia. Having thus gone all round the globe, press the speculum back towards the orbit, and the globe should project forwards. Introduce the scissors on the right side of the eye operated on, bury the blades deeply,

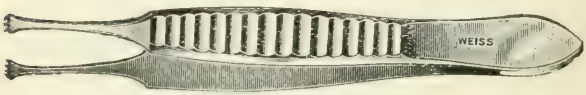


Fig. 78.—Fixation forceps.

and feel for the stretched optic nerve ; divide this whilst steadying the globe with the fingers of the left hand. The latter now takes hold of the eye, whilst any remaining tissues are divided. Wash out the socket with a full stream of hot water (100° F.). Firm pressure over the closed lid is then applied by means of a pad of cyanide gauze and bandage. The chief difficulty of the operation lies in the division of the optic nerve, particularly when it is desired to remove as much of this as possible in malignant disease of the eye.

Dangers of the Operation.—Provided the tissues are divided close to the globe, there is hardly any risk from hæmorrhage. If excision is done for acute suppuration (panophthalmitis), there is a certain amount of risk from acute meningitis, and hence if the operation must be done for this condition, the orbit

should be washed out with some antiseptic solution after the operation.

Adams-Frost's Operation.—With a view to obtaining a good support for the glass eye, and thus enabling it to move well on contraction of the recti, a small glass globe may be inserted into the cavity of Tenon's capsule, which is held open by forceps, and subsequently sutured over the globe. It is, perhaps, best to sew up the capsule and conjunctiva separately. Sometimes the globe works out subsequently, but it is generally well tolerated.

Mules' Operation.—Instead of excising the globe the contents of the sclera are removed. The cornea is removed by an initial incision with a keratome, and completed with scissors. The contents of the sclera are scooped out, and the interior cleared with a swab of sterile wool. Now a hollow glass ball of suitable size is inserted ; the sclera closed with sutures ; then the conjunctiva is sewn over. The *cosmétique* effect is excellent—a full mobile stump is left ; but there are suspicions attached to the operation by reason of liability to subsequent sympathetic inflammation.

Abscission of the Cornea.—Large staphylomata may be removed by excision with a sharp Beer's knife. The edges of the wound are drawn together and sutured, so as to retain the vitreous. A fine stump results. Occasionally there has been trouble on account of irritable ciliary nerves.

A glass eye may usually be worn three or four weeks after excision ; it must be sufficiently small for the lids to cover it completely at each blink.

The hollow thick-edged shell (Snellen's) is better in appearance and comfort than the old thin shell. Two should be used turn about. At night the shell should be removed, placed in a vessel of boracic lotion in the bottom of which is a layer of cotton-wool. A roughened shell should be changed at once.

Operations on the Socket.

When the socket is so contracted that a shell cannot be worn, a plastic operation must be performed to enlarge it.

1. Divide the bands carefully with a very sharp knife; when the bleeding has ceased apply grafts of mucous membrane removed from the lips; keep in place with pieces of lead foil suitably shaped; pack the socket with gauze and leave for a week.

2. *Maxwell's Operation.*—Dissect a flap of skin from the lower lid; undermine the lid, and push the flap into the socket; stitch in place. The flap provides new tissue, and the traction from the skin attachment deepens the socket.

3. In slight contraction of the lower fold insert two or more Snellen's sutures as for ectropion.

4. In case of a hopelessly distorted socket the author's method of making a cast should be tried. Grease the socket; fill with plaster of Paris; add water; in ten minutes remove the cast. Dehydrate the cast in alcohol, then boil in candle-wax; remove and dip a few times until sufficient wax adheres. Try the cast in the socket; increase by dipping, or pare away as necessary. Send the cast to the artificial-eye makers who will reproduce in glass.

Operations on the Muscles.—Squint.

Operations for squint are amongst the most delicate and difficult. They require patience and dexterity. The student may practise on the author's dummy (made by Weiss).

In the common convergent squint the internal rectus is too short and the external rectus too long. Operation aims at correcting this to bring the eye straight with its fellow. Taylor of Norwich (1727) first did tenotomy. For many years it was the only operation, and was performed in every degree of severity, often with a resulting deformity worse than the original squint. Attempts at mending these damages led to 'advancement' operations: the 'too-long' muscle was cut, shortened, and advanced in its attachment to the globe. The variable results, uncertainty of exact replacement of the cut tendon in its true axis, and failure due to cutting out of stitches, have lead to operations by which tendons are

shortened, and lengthened to balance each other without detachment from the globe.

All squint operations are best done under local anæsthesia, but young children require general anæsthesia. Great care should be taken not to pull on a tendon, it causes pain and the pulse may flag or stop for a few seconds; if the patient be under general anæsthetic vomiting may ensue.

Adrenalin is invaluable, but it will not prevent bleeding if the central artery of a tendon be cut.

Tenotomy of the internal rectus.

Positions of the Operator.—In front and to the left side of the patient for the left eye; and behind the patient's head for the right eye.

Instruments.—Spring-stop speculum, squint hook, forceps, straight blunt-pointed scissors, suture. Cleanse and cocaine the eye, and introduce and fix speculum in the usual way.

FIG. 79.—Strabismus hook.

1. **The Open Operation.**—Lift a horizontal fold of conjunctiva, with the forceps, immediately over the tendon of the muscle; snip the fold across between forceps and cornea; a button-hole lying across the line of the muscle results. Loosen the conjunctiva from its bed with a few snips of the scissors. Lift and cut Tenon's capsule similarly. Now straddle the muscle tendon with the forceps, seize it, lift gently, and cut it through close to the globe. Pass in a squint hook to see the muscle is quite free. Suture the wound *from above downwards*, so as to close it horizontally; there is no tension, and the effect of the operation is increased.

Observe the effect upon the position of the eye. It may be noted that after complete division of one internal rectus the globe can still be turned inwards at the time of operation, owing to the action of the upper and lower recti.

Tie the eye up with a light pad and bandage, which should be removed and left off next morning ; it is not absolute necessary to use any bandage at all. Tell the patient to *look away from* the cut muscle, to keep it on the stretch, and wear his glasses constantly.

Difficulties of the Operation.—Especially when the patient is not under a general anæsthetic, this operation is more difficult than it looks, and to do it well requires considerable practice. It is essential to make sure that Tenon's capsule is opened before a hook is introduced, otherwise it cannot pass properly under the tendon. Difficulty may be met with in the actual cutting of the tendon, which should be done with one cut, and not with little snips.

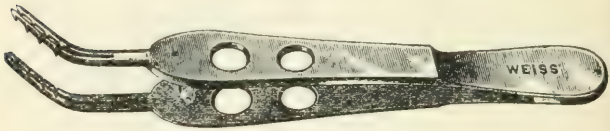


Fig. 80.—Director forceps for tenoplasty.

There are no special dangers about the operation, but it is worth remembering that the sclera has been known to be divided by the scissors or hook (sometimes with a serious result to vision), and hence scissors or hooks with sharp points should never be used.

Tenotomy tends to weaken the power of convergence ; if the muscle is reattached too far back it works at a great disadvantage; it may drag on, and depress the caruncle, causing deformity.

Tenotomy of the external rectus.—The insertion of the tendon is farther back than that of the internal rectus, so difficulty may arise in finding it, but the method of the operation is similar.

Tenoplasty (Harman's Jigsaw Operations, Fig 81).—The tendon is lengthened by making cuts which allow it to extend like a parallel ruler. Expose tendon as for tenotomy. Pass squint hook under it, slide lower blade of director forceps (Fig. 80) under tendon to replace hook. Centre forceps to axis

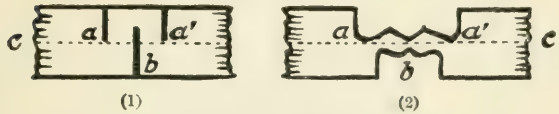


FIG. 81.—Tenoplasty.
(1) *a a'*, two half cuts; *b*, middle two-thirds cut; *c*, axis of tendon.
(2) Tendon stretched with band uniting axis.

of tendon and close. Make two cuts with scissors on either side the toe of forceps half across the tendon; make a third cut with a knife from heel of forceps along its groove two-thirds across tendon. Withdraw forceps gently. Close conjunctiva as after tenotomy. The lengthening gives 5° rectification.

FIG. 82.—Tenoplasty to effect vertical deviation.
(1) Two cuts from opposite edges of tendon each two-thirds across.
(2) *a*, cut nearest cornea being from *upper* edge; eye is turned *upwards*.

The operation may be varied to secure a vertical displacement of the eye in hyperphoria. Make two cuts only, one from each edge of the tendon two-thirds across. The cut nearest the cornea determines the direction of the movement (Fig. 82).

Advancement of a Rectus Muscle (say, the External).—The tendon is detached from the globe, shortened, and reattached closer to the cornea.

Position of Operator.—As for tenotomy.

Instruments.—As for tenotomy, with, in addition, Prince's clamp forceps, waxed silk No. O, small curved needles with very keen points, a good needle-holder.

Critchett's Operation.—(1) Expose the tendon by the open method about 5 millimetres from the cornea. (2) Secure the tendon in Prince's clamp forceps, and detach it from the globe. (3) Fix three fine silk sutures, one to each edge, the third into the middle of the muscle, 2 millimetres from the clamp. (4) Pass

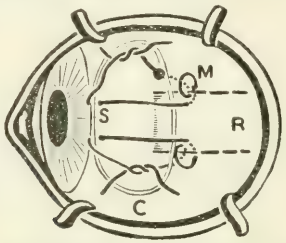


FIG. 83.—Plan of Worth's operation. The points of the speculum holding open the lids are shown, but the clamp forceps holding the rectus tendon are not shown. *C*, opening in conjunctiva; *R*, rectus tendon, *M*, suture looped about edge of tendon; *S*, suture fixed in sclera.

the free end of the middle suture into the episcleral tissue near the rim of the cornea, just beyond the muscle insertion; place the other two sutures into the like tissue above and below the cornea. (5) Cut off the piece of tendon in the clamp. (6) Tighten, as much as desired, the three sutures joining the muscle to the rim of the sclera—the middle first, then the upper and lower.

Many surgeons (*e.g.*, Worth—Fig. 83) use only two sutures, fixing them both into the thin but tough tissue of the limbus and parallel to the edges of the tendon.

After advancement bandage both eyes for a week; the sutures work loose in eight days or so.

Subconjunctival Reefing Advancement (Harman's Operation).—The tendon is shortened by taking a reef in it, very much in the fashion the laundry-maid treats frills in goffering. The tendon is neither exposed nor cut.

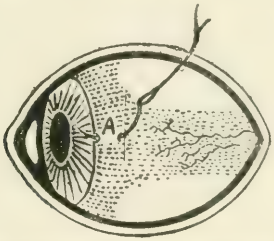


FIG. 84.—*A*, fixing anchor stitch at limbus. Shading indicates site of tendon. (See text.)

Instruments.—Reefing forceps, tendon rasp, fine-toothed forceps, scissors, good needle-holder, three No. 4 curved calyx-eyed needles threaded with No. 1 silk 6 in. long and doubled, speculum.

Position of Operator.—On side of eye to be operated on; except when fixing anchor stitch, when for right eye stand behind

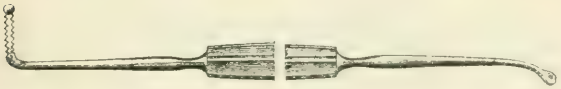


FIG. 85.—Left end, tendon rasp. Right end, needle lifter. To draw needle out of tissue press conical hole well down over point, give a slight turn to the handle; needle will be gripped and can be drawn out with ease.

patient's head, and for left eye stand on right side and reach across face.

Step 1. *Secure the Eye* (Fig. 84).—Fix an anchor stitch through the conjunctiva and outer scleral fibres at the limbus, exactly in the meridian of the eye. The assistant adducts the eye with the stitch.

Step 2. *Locate the Tendon.*—The exposed white of the eye will show three patches: two lateral creamy and one median faintly bluish with bloodvessels on it. Beneath the median patch close to the canthus is the tendon. Its fibres can often be seen shining through the conjunctiva (Fig. 84).

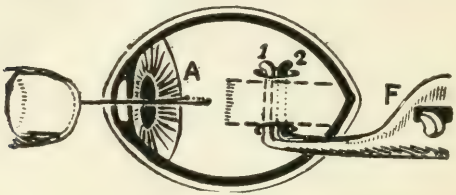


FIG. 86.—Showing steps 3 and 5. The hooks of the reefing forceps are above and below tendon (1 and 2), and both below conjunctiva.

Step 3.—Cut two parallel buttonholes 5 millimetres long, one above, one below the tendon, separated by about 7 millimetres and close to the canthus. Cut right through conjunctiva and Tenon's capsule to expose the pearly sclera (Fig. 86).

FIG. 87.—Reefing forceps. Upper blade can be slid forward or lower.

Step 4. *Rasp the Tendon* (to induce adhesions).—Pick up tendon with rasp and well rub under-surface against counter-pressure of finger. Then slip rasp under conjunctiva only and rub upper surface of tendon.

Step 5. *Reef the Tendon.*—The forceps (Fig. 87) are a pair of squint hooks which fit together. Hold forceps over canthus,

slip lower hook under tendon, lift conjunctiva over upper hook (Fig 86). Set blades of forceps to position that will give shortening of tendon required (marked on forceps 4, 6, 8, 10, and 12 millimetres), lock blades. Now slowly rotate forceps

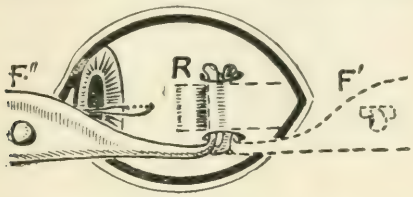


FIG. 88.—*Step* 5: Rotating the reefing forceps from *F'* to *F''*. The reef in tendon is made at *R* under the conjunctiva.

across eye to rest on nose (Fig. 88). The tendon is reefed, and the eye will be seen to come straighter.

Step 6. *Suture the Reef.*—Grip needle in holder close to its eye to leave a good length projecting, pass it under cut edge of conjunctiva, beneath forceps hooks, and make it pierce base of

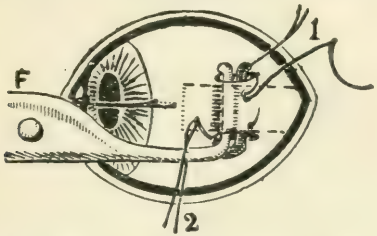


FIG. 89.—*Step* 6: Suturing the reef. 1, suture in position; 2, needle dipping under hooks to pierce reef.

reef (Figs. 89 or 90). Draw out needle with lifter (Fig. 85). Pass needle once again in same track. The base of the reef is gripped in the bight of the suture. Do the same to the other side of reef. Unlock forceps and withdraw.

If squint be of low degree slip a small bead on each suture and tie. Finish operation by tenoplasty of antagonist (p. 187).

Step 7. *Advance the Reef* (if squint of high degree).—Pass each suture through conjunctiva and fix firmly into outer

FIG. 90.—Diagram to show path of *N* (needle) under *R* (reef). *CC*, conjunctiva; *T*, tendon; *S*, sclera.

scleral fibres parallel to limbus (Fig. 91). Hold eye with anchor stitch, grip needle in middle for firmness, insert needle close to anchor stitch and push away from it to keep globe

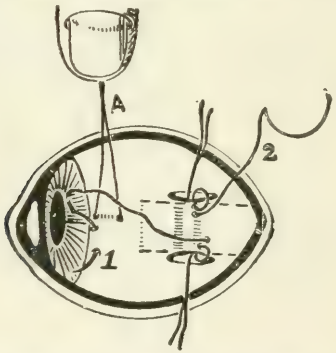


FIG. 91.—*Step* 7: Advancing the reef. *A*, anchor stitch holding eye; 1, needle gripping conjunctiva and sclera.

steady. When both sutures are in place (Fig. 92) and tied, the reef is drawn forwards and strapped tightly to the globe. Cut sutures short to 5 millimetres, and tuck ends under canthus. Finish operation by tenoplasty of antagonist.

After Treatment.—Bandage operated eye only. Wash it twice daily. Patient may be out of doors freely, but the glasses must be worn. Remove stitches on eighth day, and discard bandage. The puckering of the conjunctiva smooths out in a month.

Calculating the Effect.—Each millimetre of reef will secure 2·5° rectification in adults, or 2° in children.

(*a*) For squint up to 15°, do reefing (without advancement) and tenoplasty of antagonist; *e.g.*, child, 15° squint. Reef 5 millimetres, 10°; tenoplasty, 5°=total 15°.

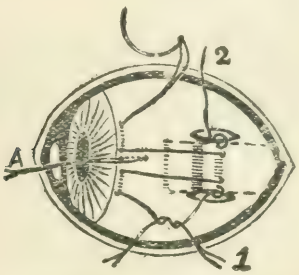


FIG. 92.—*Step* 7: Advancement sutures in position ready to be tied.

(*b*) For high degrees of squint do reefing advancement and tenoplasty of antagonist; *e.g.*, child, 35° squint. Reef 10 millimetres, 20°; advancement, 5°; tenoplasty, 5°=total, 30°; the subsequent contraction of the scar will do the rest.*

Operations on the Iris.

Iridectomy.—In cases of a penetrating wound of the cornea with prolapse of the iris, if it is considered wise to try to save the eye (see 'Wounds of the Globe'), a speculum should be

* For full details of the author's squint operations, see XVII. Internat. Congress of Medicine, London, 1913. Section IX. "Ophthalmology"

introduced, the prolapsing portion seized with iris forceps and drawn well forwards, and then cut off level with the wound. Then with a spatula gently press the stump of the iris back within the anterior chamber. This operation can only be done satisfactorily within a few days of the injury, and if there is definite prolapse, the sooner it is done the better. Unless there

FIG. 93.—Keratome.

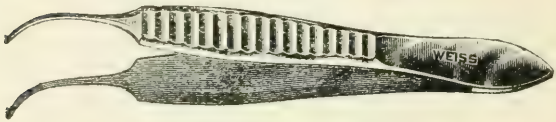


FIG. 94.—Iris forceps.

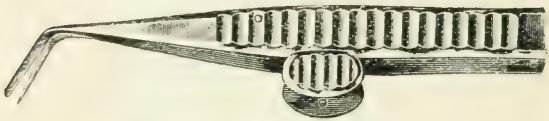


FIG. 95.—De Wecker's spring-action iris scissors.

FIG. 96.—Bowman's repositor for replacing iris after iridectomy.

is already iritis (in which case atropine is necessary), it is, perhaps, best to use eserine freely for a day or two, in order to draw away the iris from the wound; this is especially the case in peripheral wounds. Whether eserine or atropine be employed, one border of the wounded iris will probably remain adherent to the cornea; but (provided the lens had not been originally

wounded) perfect vision may be restored, and the synechia give no further trouble.

Iridectomy for Optical Purposes.—The cases for which this operation is best adapted are those in which there is a dense central nebula of the cornea, with a clear (or comparatively clear) part downwards or to the inner side. It is also sometimes performed for small lamellar cataract. It should, if possible, be performed opposite the inner and lower part of the cornea, and the iris should not be excised right up to the ciliary attachment.

Instruments.—Speculum, fixation forceps, narrow keratome, iris forceps and scissors, repositor.

Fix the globe with the forceps grasping the conjunctiva at the upper part. Introduce the keratome just within

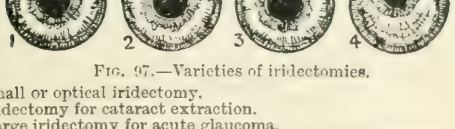


FIG. 97.—Varieties of iridectomies.

1. Small or optical iridectomy.
2. Iridectomy for cataract extraction.
3. Large iridectomy for acute glaucoma.
4. Faulty result in glaucoma iridectomy, due to incarceration of the right pillar of the iris in the sclero-corneal scar.

the corneal margin, and keep the blade parallel with, or a little anterior to, the plane of the iris. Take care not to introduce the point too far, and both enter and withdraw the keratome slowly, widening the wound slightly by a lateral movement on withdrawing. These precautions are to avoid wounding the lens, which is projected forward as the aqueous escapes. The fixation forceps may be put down, or, if necessary, an assistant takes charge of them. Now introduce the iris forceps closed, and opening them slightly when the points are opposite the inner part of the iris, seize the latter and draw it gently out; cut off the part outside the wound by one snip of the scissors. The spatula is now very gently passed over the wound, and if the iris tends to prolapse, its end is insinuated so

as to depress either side. This manipulation is to avoid future bulging or prolapse of the iris. The eye is then bandaged up for three or four days. Atropine should be instilled when the anterior chamber is reformed.

Iridectomy after iritis, see p. 199.

Operations for Chronic Glaucoma.

For indications see p. 82.

Anæsthesia by cocaine with adrenalin is sufficient.

Elliot's Sclerectomy by Trephining.—*Position of Operator.*—Behind patient's head and rather towards the side of eye to be operated.

Instruments.—Speculum, fixation forceps, graefe knife, trephine, and scissors.

Fig. 98.—Elliot's trephining. The arrow shows the flow of aqueous.

Let the patient look down. Cut and turn forward a flap of conjunctiva shown in dotted line of Fig. 98, leave an untouched piece on either side at the limbus. With a knife split carefully the upper surface of the cornea for 1 millimetre to extend flap to level of broken line in figure. Now rotate a 2-millimetre trephine on the border of the limbus, cutting out equal parts of cornea and sclera. Do a minute iridectomy *within the hole*, but do not drag out the iris, replace edges with repositor. Replace conjunctiva, close the lids, and lightly bandage. Eserine may be instilled for a day or two to keep the iris from the filtration angle. On the third day a drop of atropine may be used to

neutralize the eserine and force open the flap. The patient may be allowed up on the second day.

Variable Flap Operation (Harman's).—Replace trephine by twin scissors. Prepare conjunctival flap and split cornea as above. Pass keratome into sclera 2 millimetres from limbus, and push it on until 3 millimetres of its point appears in the anterior chamber; withdraw gently so as to save loss of aqueous. Slip the male blade of twin scissors along track of wound until 3 millimetres of its point is in the wound, close blades steadily but firmly.

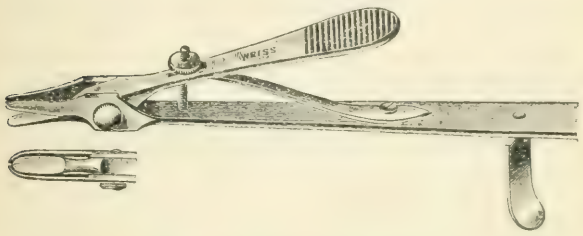


FIG. 99.—Harman's twin scissors.

withdraw gently, and aqueous should escape. A small V-shaped flap is cut held by a fine stalk to the cornea. Do a minute basal iridectomy. Finally, with the iris forceps twist the V flap over on itself so that the inner surface becomes the outer. The flap lifts up the conjunctiva like a tent and prevents closure of the hole.

Operations for Acute Glaucoma.

Scleral Puncture.—This is a rapid and most efficient mode of relieving tension and pain in cases of such severity that irid-

ectomy cannot be at once performed. Turn the eye down, plunge a Graefe knife into the globe behind the ciliary region in the space between the tendon of the superior rectus and superior oblique. Fluid will immediately escape and bulge up the conjunctiva. An anæsthetic is desirable, but in an emergency it may be done without. The pain of the puncture is momentary. If it be done without an anæsthetic, the back of the knife must be held towards the cornea; then a jerk of the globe cannot extend the wound.

Priestley Smith recommends that puncture should always precede iridectomy for acute glaucoma; it lessens the tension, deepens the anterior chamber, and reduces the risk of subsequent disastrous expulsive hæmorrhage.

Graefe's Iridectomy.—This differs from an optical iridectomy in the following points: (1) A larger wound must be made

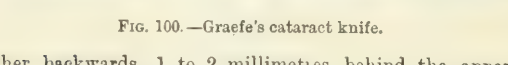


FIG. 100.—Graefe's cataract knife.

farther backwards, 1 to 2 millimetres behind the apparent sclero-corneal junction (Nettleship). It will be remembered that the cornea is a little overlapped by the sclera, like a watch-glass by the rim of the watch—in fact, as long as the track of the incision is just in front of the iris attachment, it cannot be made too far back. (2) A large piece of the iris must be excised right up to its ciliary origin, and the margins of the wound should be in healthy tissue. (3) The iridectomy should, if possible, be performed upwards, so that the resulting coloboma may be concealed by the upper lid. (4) Whereas the previous operations may be performed under the influence of cocaine, in the cases of acute glaucoma it is better to give a general anæsthetic.

Instruments.—Speculum, fixation forceps, Graefe's cataract knife (not too flexible), iris forceps and scissors, repositor. The speculum being fixed, and the conjunctival surface irrigated with boracic lotion, enter the point of the Graefe's knife

through the sclera, 1 millimetre behind the corneal margin, with the blade of the knife directed upwards ; pass it directly across in front of the iris ; transfix the cornea on the opposite side at the same level, and cut upwards, so as to include nearly one-third of the scleral margin, in which the whole incision lies, say from X to II on the clock-face (see Figs. 96 and 97). The cutting is done by a gradual to-and-fro movement of the knife, the globe being fixed by the fixation forceps, which grasp the conjunctiva firmly below the cornea.

The iris forceps are now introduced and directed towards the right side of the wound, then opened and made to seize the iris and draw it out ; the scissors then divide the membrane on

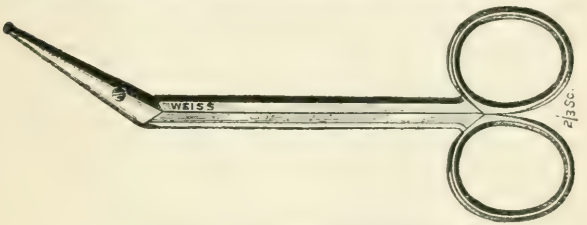


FIG. 101.—Iris scissors (Maunoir's).

the right side of the wound. The iris is now drawn steadily out as far as it will come, until a second cut can be made on the left side of the wound. Replace the edges of the cut iris with the repositor. Bandage the eye and keep patient in bed for a week ; change the dressing once daily, and bathe the lids each time it is changed.

Sometimes an iridectomy is performed for relapsing iritis or for occlusion or exclusion of the pupil. In this case it should be free, although the incision need not be quite so large as for glaucoma, and may well be made with the keratome (a broad and triangular one). In these cases the iris has generally become either tough or 'rotten' from the previous inflammation, and it is very difficult to draw it out ; it may be necessary to introduce the iris forceps more than once.

Dangers and Difficulties of Iridectomy for Glaucoma.—The anterior chamber is nearly always very shallow, and both iris and lens are pushed forwards, so that there may be great difficulty in making the incision correctly, and if a keratome be used there is great risk of wounding the lens capsule with its point; hence the operation is described as performed with the cataract knife, in which there is no such danger. Some operators, however, still prefer the use of a keratome.

The vessels about the sclero-corneal margin are engorged during acute glaucoma, and considerable bleeding often occurs when they are cut across, but this may be checked by the initial use of adrenalin. If much extravasation occurs into the anterior chamber, it may be removed by gentle pressure on the cornea with the curette, but a little blood in this situation is fairly rapidly absorbed.

Sometimes the sudden relief of tension starts a free hæmorrhage into the retina and vitreous, causing protrusion of the lens and vitreous; the eye will have to be removed. The risk may be minimized by preliminary scleral puncture.

Operations for Cataract.

Operations for Soft Cataract.—For cataract in children or removal of lens in high myopia.

1. *Simple Needling.*—The pupil is to be well dilated with atropine, a speculum introduced, or the lids held open by the

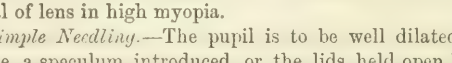


FIG. 102.—Bowman's needle with stop on shank.

fingers, and a sharp cataract needle inserted obliquely through the periphery of the cornea and into the lens at the centre of the pupil. The needle-point is moved up and down and from side to side in the face of the lens, so as to cut the capsule and enter the lens; it is withdrawn with great care to avoid wounding the iris. Atropine is again applied for a day or two.

The lens matter imbibes the aqueous, swells up more or less,

and is gradually absorbed. At the end of six or eight weeks the needling will probably require to be repeated, and sometimes the case will need three, four, or even more operations. The tough opaque capsule, which is sometimes left at the end, is either torn with two needles, or cut across with De Wecker's special scissors introduced through a small peripheral corneal wound.

This tedious, but as a rule very safe, method of treating soft cataracts may be replaced by :

2. *Suction.*—A free needling is performed. A week later the lens will be soft and swollen. Then a keratome or broad-cutting needle is introduced through the cornea on the outer side, and through this wound the nozzle of a special form of syringe is passed into the lens, and the cataract gently sucked out. After-treatment similar to the last.

3. *Curette Evacuation.*—A curette is used instead of a syringe, and by pressure exerted with the index-finger through

FIGS. 103 AND 104.—Curette and Cystitome (Moorfield's patterns).

the lid the soft lens matter is squeezed gently out along the curette, the end of which is introduced just within the anterior chamber. In operations 2 and 3 watch the eye during the week the lens is left to soften lest tension increase dangerously.

Extraction of Senile Cataract—*The 'Modified Linear' Method.*—Iridectomy is performed as a step of the operation. In a few cases, chiefly those of very slowly maturing cataract, or those in which one eye has been previously operated on and lost in consequence of the operation, a preliminary iridectomy is performed upwards ; and some weeks or months later the extraction is completed.

Instruments.—Speculum. Graefe's cataract knife, fixation and

iris forceps, iris scissors, cystitome or capsulotomy forceps, curette, repositor. The following instruments should be had in readiness, although not usually required; wire loop or scoop for extraction of the lens, lid elevator.

Fig. 105.—Cataract spoon.

The use of cocaine has practically superseded chloroform or ether in cataract extraction; but in the case of very nervous patients it is better to give a general anæsthetic for fear of a sudden squeeze or movement of the eye during the operation. Under cocaine the only really painful part of the operation is the iridectomy, and the patient should be warned of this before the iris is seized and drawn out.

Fig. 106.—Taylor's loop or vectis for extracting dislocated lens.

Position.—The patient lies flat on a high table, and the head is carefully steadied by a pillow. The surgeon stands behind the head, cleanses the eye, and introduces and fixes the speculum.

1. For operation on the right eye, take the fixation forceps in the left hand, seize the conjunctiva below the cornea exactly in the vertical meridian, fix the globe so that it looks somewhat downwards, and make the section at the upper edge of the cornea so as to include about two-fifths of its circumference (X to II on the clock-face). The cataract knife is entered towards the outer side of the eye, at, or a very little behind, the sclero-corneal margin, with its point directed towards the centre of the pupil. As soon as it has entered the anterior

Fig. 107.—Outline of peripheral section.

chamber, the handle is depressed and the blade carried across in front of the iris, so as to transfix the cornea at the same level as its point of entrance. By a gentle to-and-fro movement of the knife it is made to cut outwards ; as it does so, the edge of the blade is sloped a little forwards, so that the middle of the incision is on a slightly anterior plane to that of either end. This is to favour the escape of the lens, which tends to emerge, not directly upwards, but forwards and upwards—*i.e.*, its upper edge is tilted forwards by the pressure on the lower part of the cornea. Take care whilst completing the section not to press

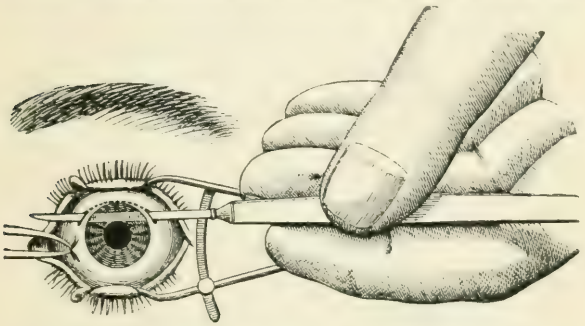


FIG. 108.—Peripheral linear section.

The fixation forceps should grasp the conjunctiva below, and not to the inner side, as drawn in this figure.

on the globe with the fixation forceps. They should, on the other hand, be simply exercising downward traction.

2. Lay down the knife ; let the assistant take over the fixation of the globe ; then with the iris forceps in the left hand and the scissors in the right perform a medium-sized iridectomy.

3. Introduce the cystitome, held in the right hand, and with the blunt angle of its end first ; then turn the instrument so that its point is directed towards the lens, and cut the capsule thrice, so as to describe a triangle base upwards. Some operators prefer the capsulotomy forceps ; they are passed in closed, then opened on the surface of the lens, and gently

pressed to engage the teeth; closure of the jaws and a gentle movement will bring away a large piece of capsule.

4. Relax the pressure of the speculum—best done by the assistant drawing it forwards so as to keep the lids apart, but not to press on the globe. With the repositor gently press down the upper lip of the wound so as to make the wound gape slightly; then apply the curette over the *lower* part of the cornea, and exercise steady pressure with it by means of its convex surface. The lens should now present in the wound, and the pressure is to be kept up until it emerges, but relaxed after the widest part of the lens has come through. (At this stage injudicious pressure will be followed by escape of vitreous.) Remove the speculum.

5. Examine the pupil to see if it is uniformly black, or if any part of the lens has remained behind. If the latter, exert backward and upward pressure, with the index-finger placed on the lower lid. If the cataract has been a hard one and complete, this will probably not be required. Otherwise the remains of the lens should be coaxed out, if they will come without prolonged manipulation, which is decidedly dangerous; it is better to leave some lens matter than to incur the risk of inflammation.

6. Perform the toilet of the iris; replace with the repositor the cut edges, so that each lies neatly in position pointing to the centre of the cornea. Be sure they are not nipped in the angles of the wound (see Fig. 81). Finally, place a pad of cyanide gauze with absorbent cotton-wool over each eye, and bandage. A four-tailed bandage, the ends passing above and below the ears, is least likely to slip.

The 'Simple Extraction.' — So called because it is done without iridectomy, but as an operation it is rather more difficult than the foregoing.

Instruments.—As before, except for iris forceps and scissors.

Position of Operator.—As before.

This operation can only be done with a well-dilated pupil. The lens will not come through an unyielding pupil.

1. The incision should have puncture and counter-puncture in the scleral margin, and be carried out and finished in the cornea, a millimetre or two below the limbus (Fig. 98).

2. Introduce the cystitome and cut the capsule, as in the other operation.

3. Remove the speculum. Tell the patient to look down. Draw the upper lid up with one finger. Place the curette horizontally on the *upper* margin of the cornea marked by the * in the figure, and press gently but steadily. (Pressure on this part causes the vitreous to push the lens forward.) The upper edge of the lens will be seen to slowly tilt up and glide round the border of the iris ; as soon as the bulk of the lens is through the iris relax the pressure, and draw out the lens with hook or cystitome.

4. Replace the iris carefully.

5. Instil atropine and bandage.

It is a very pretty operation. The special risk lies in subsequent prolapse of the iris, and formation of anterior synechia.

FIG. 109.—Incision for 'simple' extraction.
* Shows point of pressure during expression of cataract.

Some operators seek to guard against this by making a small hole in the base of the iris upwards.

'The corneal flap extraction without iridectomy gives, under favourable circumstances, the most perfect result, but it is neither adapted to all cases, nor does it secure the same almost absolute certainty of success as the scleral flap extraction with iridectomy' (Fuchs).

Difficulties and Dangers of these Operations.—If the left eye is operated on, the knife must be held in the left hand in making the section. An immature cataract is very prone not to come out cleanly ; on the other hand, an over-ripe one may also give trouble. The wound may be too small to allow of the exit of the lens, and in this case it must be enlarged with scissors. The rent in the capsule may similarly be insufficient (as shown by the lens not presenting on pressure), and the cystitome must

be again used. But the chief accident which is to be dreaded at the time of operation is *escape of vitreous*. If the section be made too far back, or if the vitreous be too fluid, this may occur during the moment the pressure is applied, or it may follow the escape of the lens (generally due to the pressure being continued too long).

If vitreous present before the lens, the loop or the scoop must at once be introduced, passed behind the cataract, and the latter gently drawn out by means of the projecting lower edge of the instrument. The bead of vitreous may then be snipped off with scissors, and the eye bandaged as soon as possible.

The chief remaining complications are the following:

1. Vomiting or coughing immediately after the operation may produce hæmorrhage into the eye, or escape of its contents. Hence the importance, where a general anæsthetic is used, of carefully preparing the patient, and the superior advantage of using cocaine.

2. Iritis coming on during the first three or four days. It is to be suspected if the patient complains of much pain in the forehead and eye, and is to be treated by increasing the atropine and applying leeches to the temple.

3. Suppuration starting in the wound and spreading to the whole globe. Pain, restlessness, chemosis of the conjunctiva, and a yellowish tinge about the wound and pupil, are the chief signs. As a rule, it leads to disorganization of the globe, and necessitates excision; but if recognized at first, the opening of the wound and irrigation through a fine nozzle with an antiseptic solution, or the application of the galvano-cautery to the wound (in the very earliest stage) has been occasionally followed by arrest of the process.

Severe iritis and suppuration are the chief causes of complete loss of vision after cataract extraction.

4. There is a very small risk of sympathetic ophthalmia, since the wound practically lies in 'the dangerous area.'

Modifications of the Operations.—The capsule may be cut with the Graefe's knife, and the use of the cystitome avoided. The

lens may be got out in its capsule entire by means of the scoop. There is some variety in the kind of knife used—*e.g.*, the old corneal flap operation was done with a Beer's triangular knife.

Immature Senile Cataract.—(See also p. 101.)

Förster's Operation.—An iridectomy is performed; then the lens is gently massaged through the cornea with the intent of rumpling the anterior epithelium and promoting extension of the opacity through the cortex. Later the ripened cataract is extracted. Some workers report highly of the procedure.

McKeown's Operation.—The operation for extraction is performed, and in its course means are taken to insure complete evacuation of the unripe cortex. (1) After the iridectomy a hypodermic needle connected with an irrigation apparatus is

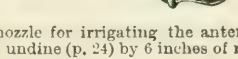


FIG. 110.—Harman's nozzle for irrigating the anterior chamber. To be attached to an undine (p. 24) by 6 inches of rubber tubing.

inserted beneath the lens capsule, and fluid is forced between the capsule and the lens. (2) After the evacuation of the lens the remnants are washed out with a stream of normal saline solution at 99° F. This second procedure is good. McKeown's original apparatus is cumbersome; an Undine (Fig. 15) with 6 inches of rubber tube on the spout and a short nozzle is all that is required.

After-Treatment of Cataract Cases.—The bandage and pad are changed at the end of forty-eight hours, the lids gently bathed with warm water, and a drop of 1 per cent. atropine instilled between the lids to forestall traumatic iritis. The atropine and a fresh dressing are applied daily until six or seven days have elapsed, when a shade may be worn and the patient allowed up. Previous to this, it is best to keep the patient in a darkened room.

At the end of a fortnight the patient may go out, wearing protective goggles, and as soon as the wound is soundly healed

and the eye quite white, the vision should be tested and glasses ordered. When the eye has lost its lens (aphakia) glasses are needed for distant and near vision (p. 136).

After-cataract results from thickening of the remaining lens capsule. This is detected by oblique illumination (the pupil being dilated), and requires one or more needling operations.

Intracapsular Extraction of Senile Cataract. — Smith's operation for ripe or unripe cataract. The lens is expressed from the eye entire in the unruptured capsule.

Method.—(1) A large section is made, including nearly half the corneal circumference. Puncture and counter-puncture are in the sclero-corneal margin, but the section continues in the clear cornea rather like that shown in Fig. 98. (2) A small iridectomy is performed. (3) The eye speculum is removed, and the upper lid held up with a hook by an assistant. (4) The operator places the olive-headed point of a squint hook on the cornea over the lower border of the lens and presses thereon. This pressure (with or without some adjuvant pressure on the upper border of the incision with a spoon) will rupture the suspensory ligament and expel the lens in the capsule.

The eye is bandaged for a week, and no drops are used. The operation has given rise to keen controversy owing to the frequency of loss of vitreous.

Operations on the Orbit.

Exploration. — 1. Search for an embedded *foreign body* requires no more than a sufficient opening to admit the little finger in the direction indicated. Its size and shape must decide whether an attempt may be made to pull it out with forceps, or a more extensive operation performed. It is better to cut tissues purposefully than tear them haphazard.

2. To feel the optic nerve in case of *suspected new growth* the external rectus must be divided. Operate as for squint, but secure the cut tendon with a suture so that it may be reattached

Krönlein's Operation.—When a retro-ocular growth is so large that it cannot be removed from behind the eye the outer wall of the orbit may be displaced.

Instruments.—Scalpel, forceps, retractors, bone-saw, chisel and bone forceps, mallet, artery forceps and sutures.

Shave the brow and the skin over the temporal region.

(1) Make a semicircular incision from the anterior part of the temporal ridge forwards to within 5 millimetres of the external canthus, and backwards a short way along the zygoma. Turn back the flap. (2) Cut the periosteum at the exposed border of the orbit, and strip off the lining periosteum from the inside of the outer wall of the orbit. (3) Cut the base of the external angular process with saw or chisel, and prolong the incision into the spheno-maxillary fissure. Cut the base of the orbital process of the malar bone, and prolong the incision to the same fissure. Dislocate the bony wall outward. (4) Cut the periosteum horizontally, and the contents of the orbit will be exposed, can be explored, or operated upon. (5) Replace the bone and close the wound carefully.

Exenteration.—Total removal of the orbital contents is necessary for some malignant growths.

Instruments.—Scalpel, scissors, periosteal elevators, artery forceps.

(1) Make a circular incision round the margins of the lids to include all lashes and glands in the excised tissue. (2) Split the skin from the stumps of the lids down to the orbital margin. (3) Incise the periosteum round the margin, and strip it carefully from the walls with an elevator; checks will be met with as foramina and fissures are met. (4) Gather the whole orbital contents within the periosteum, draw it tightly forward, and then cut the optic nerve as it is put on the stretch at the apex of the orbit. (5) Pack with gauze. (6) In ten days' time, when granulations cover the walls, cut a number of small Thiersch grafts, place in position, and secure by lightly packing with gauze. Leave undisturbed for a week.

XXXVI. EYE CONDITIONS IN SCHOOL-CHILDREN.

With the passing of the Acts for the medical inspection and treatment of school-children some knowledge of the common eye conditions found in children attending public elementary schools may be of value.

Recently I examined 22,000 English children in the East End of London.

The conditions found amongst these may be divided into two classes: (1) external diseases; (2) functional disorders.

1. External Diseases.

About 2 per cent. of the children had some eye disease. Of these the bulk, or 75 per cent., were cases of **blepharitis**—sore eyelids—an indication of dirty hands and unwashed faces, possibly associated with some visual trouble, for tired eyes are rubbed more than usual. Ten per cent. of these showed severe and chronic ulceration, with more or less loss of lashes.

Phlyctenules come next in order of frequency, accounting for 15 per cent. of the cases. It will be remembered how serious is this inflammation in its lasting effects on the transparency of the cornea, and, consequently, on visual acuity.

Acute Conjunctivitis accounted for 10 per cent. of the cases. Most of these appeared to be due to infection with the Koch-Weeks bacillus.

Trachoma was extremely rare, only two certain cases and one doubtful case being found, or less than 1 per cent. of the diseased conditions.

For the rest, interstitial keratitis due to congenital syphilis, lachrymal abscess, eyes lost from earlier accident or disease, and congenital anomalies, accounted for 8 per cent.; whilst there were five children with damaged eyes from ophthalmia neonatorum, or about $1\frac{1}{2}$ per cent. of the diseased conditions.

It must be remembered that the blind and partially blind children are withdrawn from the elementary schools to special blind schools.

Influence of Social Conditions.—These children were grouped into 'dirty,' 'average,' and 'clean' groups, and the incidence of external diseases noted for these groups. The percentage of disease amongst the dirty was 1·9; amongst the clean 0·8. The dirty suffer twice as much as the clean.

Towels in Schools.—There is no more fruitful mode of spreading eye infection than a promiscuous use of towels. In residential schools each child should have exclusive use of his own towel. The towels and other toilet appliances, as face-rubber or sponge and tooth-brush, should be hung on a hook, marked with the number of the child. In schools where these regulations are enforced 'school ophthalmia' is almost a thing of the past.

In day-schools the matter is more difficult. It is not possible to supply towels for each scholar. We best get over the difficulty by a rule allowing the use of wash-basin and towels for *hands only*, and prohibiting the washing of faces at school. Dirty children should be sent home to wash Should there be an outbreak of conjunctivitis in a day-school, the towels should be withdrawn from use. In an epidemic of muco-purulent conjunctivitis, due to Koch-Weeks bacillus, investigated in a day-school, the spread of the epidemic was checked promptly when the issue of towels was stopped.

Discharging Eyes.—Children with discharging eyes should be excluded from school, notice of the exclusion being given to the proper authority, so that treatment may be effected.

2. Functional Disorders.

Disorders of vision are by far the most frequent source of trouble amongst school-children. Of 30,000 London school-children 26 per cent. were found to have defective visual acuity (Dr. Kerr's return, 1903); over 1 in every 4 children could not pass the test of reading $\frac{6}{9}$ on Snellen's card. The conditions were worse in the poorer, overcrowded districts, for there 30 per cent. failed, and amongst the alien Jews of the East End 36 per cent. were defective. Again, girls have rather worse vision on the average than boys. In one good-class

school I found 18 per cent. deficiency in boys, and 26 per cent. in girls.

The effect of social environment and of sex on vision, or, it may be said, on the growth of the eye, is striking. To some extent this may be due to the early age at which poor children and girls are set to work at home, before and after school-hours.

Wits and Sight.—In practical work it has been found again and again that 'dull and stupid' children were so because they could not see; so if only a half or a third of these school-children who fail to pass the vision test have serious defect of vision, there is enough to account for much failure in school teaching.

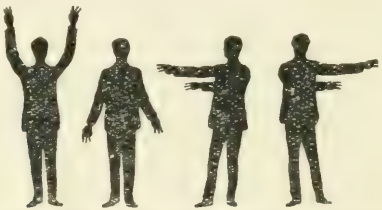


FIG. 111.—Showing method of responding to E test.

Testing the Vision.—Take the vision of each eye separately, and also of both together. Snellen's test card should be exposed in good daylight, but not in direct sunlight. The letters should be pointed to by a teacher to help the attention of the child.

Children over ten years of age who cannot read $\frac{6}{9}$, and those from seven to ten years who cannot read $\frac{6}{12}$, should have their eyes examined.

If the vision of infants under seven years of age is to be tested, the **E** test card should be used. This is made up of different sized **E** block letters—in various positions. The child is given a card with an **E** thereon, and is directed to hold this in the position of the letter shown. Or the children should be taught to hold up their fingers in the direction of the limbs of the letter. A judicious bribe of 'sweets' adds to the child's interest, and better results are obtained.

The inability of young children to see ⅛ does not necessarily imply poor vision, for there is in all these tests a mental factor; the greater the familiarity with the letters the more easily are they recognized.

Errors of Refraction.—For the most part the errors amongst the younger children are those of hypermetropia, with or without astigmatism. Amongst the older children myopia increases, especially amongst those who are astigmatic.

The refraction of 1,000 London school-children with defective

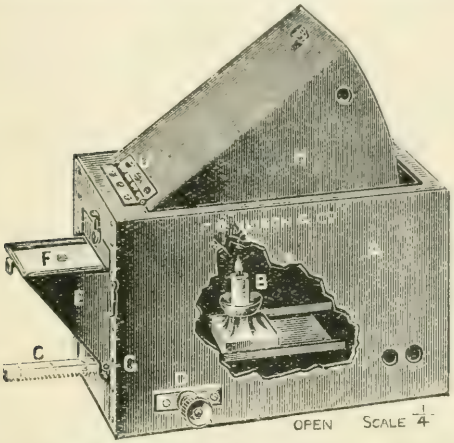


FIG. 112.—Harman's photometer for measuring illumination.

B, Candle on racked stage; it is moved forward until the spot (F) shows that the room light and the candle-light balance. The value of the light is then read off on scale (C) in foot candles.

vision examined by myself at hospital under atropine worked out as follows (figures give percentage):

H.	H.As.	Mx.As.	My.	My.As.	Odd Eyes.
42·55	28·64	7·09	9·27	10·45	2

Amongst the younger children myopia with or without astigmatism was rare ; it increased steadily with each year of age, whilst hypermetropic astigmatism correspondingly declined in frequency. These findings point to the necessity for—

Proper Print and Light in all Schools.—Vision depends on the detection of contrasts, hence a good light is necessary to show up these contrasts.

An adult can read letters in a poor light because he is familiar with the letters ; a child has not this familiarity, so needs a sufficient light.

Windows should be large, filling nearly the whole of the (children's) left-hand wall of the room right up to the ceiling ; then the desks will be well lighted, and the shadow of the writing hand will not obscure the writing.

Artificial Illumination of each desk should not be less than three foot candles—*i.e.*, the light given by three standard candles at the distance of one foot. It should be steady and white in colour.

This is Double Pica

This is Pica, the smallest school type

Desks.—The seat should be of such a height that the child's thighs rest upon it while the feet are on the ground ; the desk height should be such that when the child sits erect the flexure of the elbow is just on a level with the edge. The desk should slope 15° down towards the child ; whilst for reading, the book should be tilted on a frame to 50°.

Print.—The greatest contrast is obtained by leaded lines—

i.e., well-spaced lines, of not more than 4 inches in length, and with heavy black type of the 'clarendon' style.

In infants' classes—under five years—the smallest type should be double pica (Jaeger 14), and in upper standards the type should not be smaller than pica (Jaeger 10). The paper should be hard pressed, but not highly glazed. No print should be held nearer to the eyes than 12 inches.

Writing.—Upright writing with a broad pen is the best from all points of view.

Slates should not be permitted in a modern school: the contrast of the writing and the background is not sufficient. Besides, slates are dirty: children will spit on them to clean them.

Blackboards should have a good dull black surface, which must be renewed frequently to prevent 'shine.' The board should be placed on the children's right-hand side. The letters marked on the board should not be smaller than 2 inches square (Snellen's D 36).

Needlework should be excluded from infant classes; woolwork should be taught instead. In the first lessons on needlework white calico and red or black sewing cotton, with large-sized needles, should be used. Fine needlework should not be permitted in school. Should any scholar be found to excel in fine needlework she should be medically examined, lest she be myopic.

Myopes.—Fine work, particularly needlework, should be prohibited in any degree of myopia exceeding 1 dioptre. Knitting should replace sewing, and the child should learn to do it by touch and not by sight.

Myopes of 6 D and more should, in most cases, be provided for in special schools, such as have been established by the London County Council.

Spasm of Accommodation.—In overworked and under-fed children there may be complaint that 'the print suddenly goes misty,' *i.e.*, failure of accommodation; in some cases they also temporarily fail to see in the distance, *i.e.*, spasm of accommodation (see p. 152).

Squint.—The urgency of proper treatment of these cases cannot be too much insisted upon (see p. 140).

Spectacle Parade.—Teachers should periodically examine the spectacles of children to see if they be straight or not.

Cigarette Smoking.—Amongst the boys this practice will not infrequently account for deterioration in work. General dulness and inattention, some loss of visual acuity, irregularity of writing, both in the formation of the letters and in alignment, are common symptoms. The pernicious practice of children smoking cheap and nasty cigarettes need not be laboured.

XXXVII. EXAMINATION QUESTIONS.

The student is advised to test his knowledge by means of the following questions, a good plan being to answer them very briefly on paper, and then revise the answers with the book. Note also directions at the head of the Index.

1. What is meant by Phlyctenular Conjunctivitis? What are its usual complications, and how should they be treated?

2. Define or explain the terms Entropion, Hypermetropia, Blepharitis, Nystagmus, Synechia, Staphyloma.

3. Describe the symptoms of a case of Acute Iritis. What are its usual causes, and how would you treat a case?

4. Describe the normal course of the tears from the Lachrymal Gland to the Nose. How would you treat a case of Lachrymal Obstruction with Abscess?

5. Give the treatment in detail of a case of Convergent Strabismus in a child.

6. How would you test for and correct Hypermetropia in a child of twelve years?

7. Name the chief varieties of Cataract, and describe the operation for extraction of a senile one.

8. How would you decide when a case of Senile Cataract is ready for operation? Mention the chief risks of the latter, and explain the term Secondary Cataract.

9. Ophthalmia Neonatorum: mention its complications, and describe its treatment, in full.

10. How would you distinguish between Syphilitic and Rheumatic Iritis? How does the treatment differ in the two cases?

11. What are the chief causes of Optic Neuritis, and how do you recognize its presence?

12. What is meant by Epiphora, and to what may it be due?

13. What are the ocular symptoms met with in Locomotor Ataxia?

14. Describe the symptoms, progress, and treatment of Interstitial Keratitis. What other eye lesions may be due to Inherited Syphilis?

15. What is meant by Diplopia? What ocular symptoms are present in a case of complete paralysis of (*a*) one third nerve; (*b*) one sixth nerve; (*c*) the cervical sympathetic on one side?

16. How would you treat a case of punctured wound in the ciliary region? Describe the symptoms of (*a*) Sympathetic Irritation; (*b*) Sympathetic Inflammation.

17. Describe the symptoms, treatment, and results of a case of Corneal Ulcer in a strumous child. What is meant by Pannus, and how would you treat it?

18. Give the chief symptoms and treatment of Acute Glaucoma, and contrast them with those of Chronic Glaucoma.

19. What are the chief Intra ocular Tumours? Describe the chief features of Rodent Ulcer affecting the eyelids; and of Molluscum Contagiosum.

20. To what may Hæmorrhages into the Retina be due? Mention the chief features of Retinal Detachment.

21. Give an account of the course of the lymph circulation within the eye; indicate the nature of the pathological conditions that may be set up by an interference with the flow; and how such conditions can be ameliorated.

22. Compare and contrast the actions of atropine, cocaine, and eserine; show in what respects they are antagonistic or complementary one to another.

INDEX

It is a good exercise for the student to go through the index and ask himself the meaning of each reference. If he has not a clear idea of it in his mind, he should re-examine the text.

Figures in **heavy type** *indicate chief references.*

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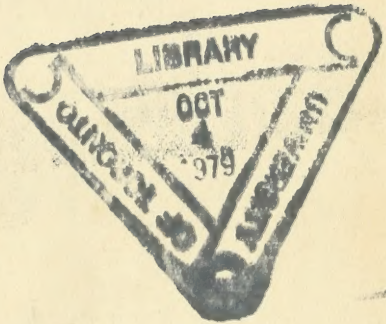
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